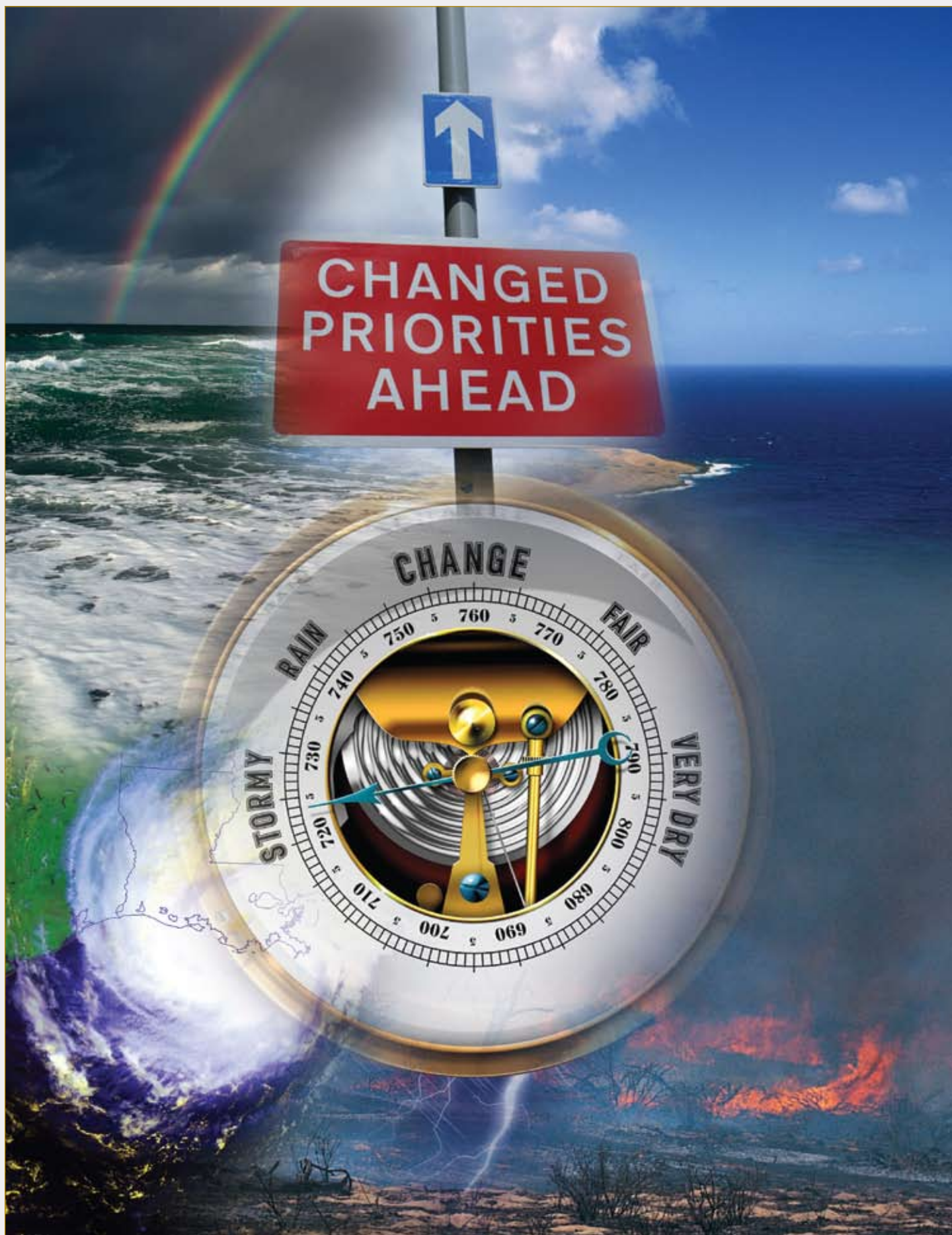


NOAA'S NATIONAL CLIMATIC DATA CENTER

2008
ANNUAL REPORT







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In 2008, the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) served the Nation as an authoritative resource for climate information. In delivering climate services and in transitioning research to operations, NCDC again met or exceeded its annual performance measures and also strengthened interactions with users; partnerships with national and international organizations; and its ability to provide data access through tools, systems, and employee initiative. As NOAA embraces climate change as an organizing theme, NCDC is ready to provide relevant and reliable information and service to help the Nation plan and adapt to this challenge.



In September 2008, NCDC reached a milestone, commissioning the final site in its 114-station U.S. Climate Reference Network (USCRN) for the continental United States. Coupled with an ongoing commitment to the network's operations, maintenance, and data access, this ensures that the national climate signal can be confidently monitored. NOAA's National Weather Service (NWS), Regional Climate Centers (RCCs), and Atmospheric Turbulence and Diffusion Division (ATDD) and NCDC established a framework for a modernized U.S. Historical Climatology Network (USHCN-M) to regionally complement the USCRN.

NCDC expanded climate service activities, focusing to engage key economic interests, raise awareness, and determine requirements for weather and climate information. NCDC sponsored a workshop for data users in the plant sector, including landscape architects, golf course architects, nurseries, arboreta, and similar industries, and co-sponsored workshops on water resources, tourism, and civil infrastructure. NCDC served millions of users with over 335 terabytes of data through legacy and emerging systems including the following: NOAA Virtual Data System (NVDS), National Operational Model Archive and Distribution System (NOMADS), Comprehensive Large Array-data Stewardship System (CLASS), and a web-based portal for drought.

NCDC remained engaged in national and international scientific collaborations, including hosting of the World Data Centers (WDCs) for Meteorology and Paleoclimatology, U.S. Global Climate Observing System (GCOS) Program Office, Global Observing Systems Information Center (GOSIC), and GCOS Surface Network and GCOS Upper Air Network Lead Data Centers. The Climate Database Modernization Program (CDMP) rescued data from old paper records, digitized them, and added them to databases. NCDC led development of a procedure that will be used across NOAA to identify, appraise, and decide what scientific records are preserved in a NOAA archive.

The Center made important contributions to the advancement of climate science in 2008. NCDC provided leadership in the production of U.S. Climate Change Science Program (CCSP) reports, particularly the synthesis report on climate change impacts for the United States. NCDC led in the development of systematic, comprehensive, and sustainable Climate Data Records (CDRs) for major satellite missions (including POES, GOES, and NPOESS). Through a series of workshops, the Center engaged academia and partners, including the monthly and annual State of the Climate reports, and offered the user community an authoritative snapshot of climate assessments on a national and international basis. NCDC scientists continued important applied research on baseline climate data sets, on quality control and assurance techniques and reanalyses, and on climate assessments and the development of climate indices. During the year, NCDC's Paleoclimatology Group added dozens of new time series that document trends in temperature and other environmental variables over the past 2,000 years, extending a vital historical record.

From education and outreach to applied climate science, NCDC employees continuously make important contributions to the Nation and to our community.

I invite you to learn more about our activities and accomplishments described in this report.

A handwritten signature in black ink that reads "Thomas R. Karl".

Thomas R. Karl, L.H.D.
Director

MAJOR MILESTONES

NEW NOAA “WHAT TO ARCHIVE” PROCEDURE PUBLISHED

A major achievement in 2008 was the development of a universal procedure that will be used across NOAA to identify, appraise, and decide what scientific records are preserved in a NOAA archive. The document, entitled *NOAA Procedure for Scientific Records Appraisal and Archive Approval*, outlines the four-step process. It applies to accepting or rejecting newly acquired scientific records into a NOAA archive and also to retaining or disposing of existing records held in a NOAA archive. The procedure's use and authority have been incorporated in a recently updated NOAA Administrative Order (NAO 212-15) entitled *Management of Environmental and Geospatial Data and Information*.

To develop the new “what to archive” procedure, NCDC led a team comprised of data management experts across all NOAA Line Offices and Goals. The development involved an extensive literature review of past work in this area, coordinating reviewer comments from both inside and outside NOAA, and presentations at various forums. The procedure was unveiled in June at a joint workshop

of NOAA data managers and the NOAA Science Advisory Board's Data Archive and Access Requirements Working Group (DAARWG). DAARWG commended NOAA on the procedure and recommended that a final document be produced. An outcome of this procedure is that NOAA will now have a corporate methodology to determine what data are preserved in NOAA archives as opposed to the *ad hoc* methods that had existed at each data center and center of data.

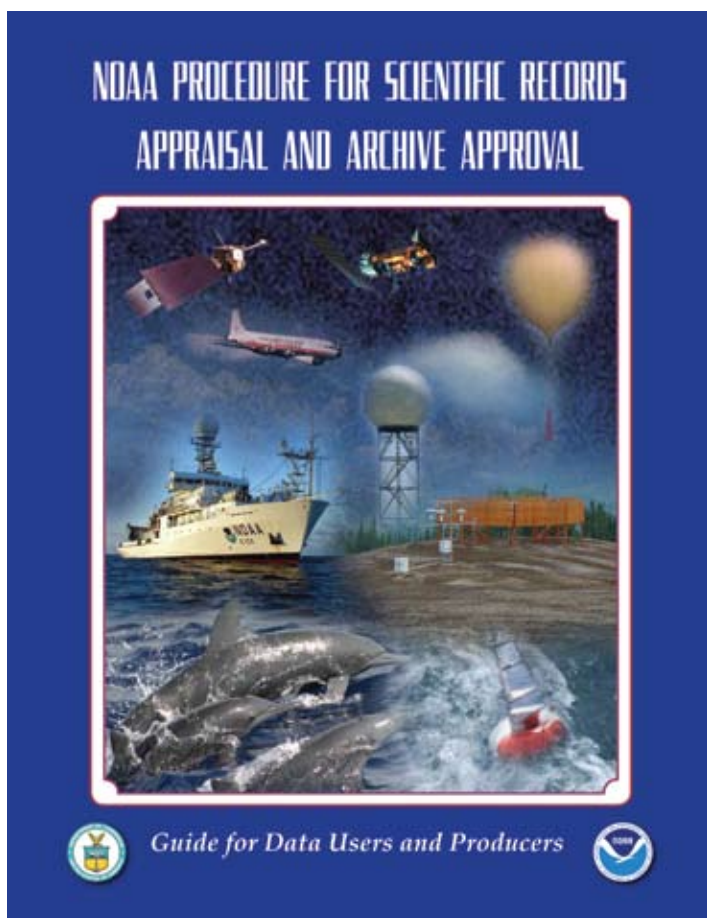
Two versions of the procedure have been produced. A *Guide for Data Users and Producers* is a four-page highly graphic brochure intended to give an overview of the procedure. A *Guide for Data Managers* describes in detail the step-by-step process that data managers will use to determine what scientific records are preserved in a NOAA archive. These two documents are available at <<http://www.nosc.noaa.gov/docs/products.html>> and NAO 212-15 is available at <http://www.corporateservices.noaa.gov/~ames/NAOs/Chap_212/naos_212_15.html>.

NCDC ASSUMES MANAGEMENT OF CLIMATE DATA RECORD PROJECT

In 2008, NCDC significantly extended its CDR efforts through the start of dedicated Project and Grant Offices. Following the principles outlined by the U.S. National Research Council (NRC) and other organizations, NOAA's CDR Project promises to unleash the potential of archived satellite data to address critical climate change questions. In order to accurately detect subtle climate changes and variations, it is vital that the measurements from different satellites be merged together and analyzed using proven scientific techniques. The succession of prior satellites, with different designs and changing performance qualities, makes combining all past and current observations into consistent long-term records a major challenge. The CDR Project addresses that challenge.

The CDR Project will produce two important types of data records:

- *Climate Data Records* (CDRs) are created from the initial data collected by satellites. Examples include atmospheric and sea surface temperatures, snow and ice conditions, and atmospheric greenhouse gas concentrations. CDRs reveal Earth's short and longer-term environmental changes and variations, allowing scientists to better understand the climate system; assess the state of the climate on regional, national, and global scales; and project future climate states.



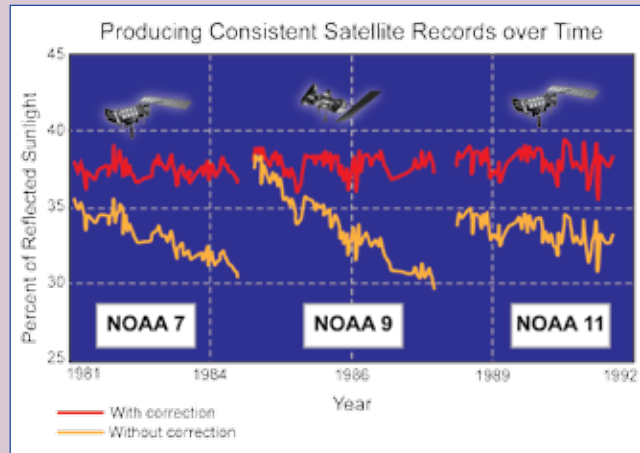
- *Climate Information Records (CIRs)* are created from CDRs and provide specific information about environmental phenomena of particular importance to science and society. Examples include hurricane trends, Arctic sea-ice coverage, and drought patterns. This information allows businesses, resource managers, decision makers, and the public to better understand and adapt to climate changes and variability, develop strategies to minimize risks, and mitigate possible impacts on society.

Environmental satellites remotely measure different Earth system properties from space. Over time, satellite sensors degrade and new satellites—sometimes with improved designs—are launched to continue the measurements. Without proper corrections, false trends in the data may be observed, caused by the observing system rather than the environment. These data can be accurately calibrated by measuring a well-understood and slowly changing target, such as a barren desert, or by comparing these measurements with those made at the same time by other observing systems, including other satellites. These scientific corrections help create consistent and complete data records.

NOAA's CDR Project is *systematic* because it progressively develops CDRs using a consistent and well-defined

set of improvement milestones, *comprehensive* because it encompasses a wide variety of both current and potential CDRs and fully addresses management and preservation of these records, and *sustainable* because it supports continuous record updates and can incorporate improved techniques as they become available.

The CDRs and CIRs will benefit society by helping scientists, decision makers, and stakeholders develop strategies that could improve the Nation's resilience to climate

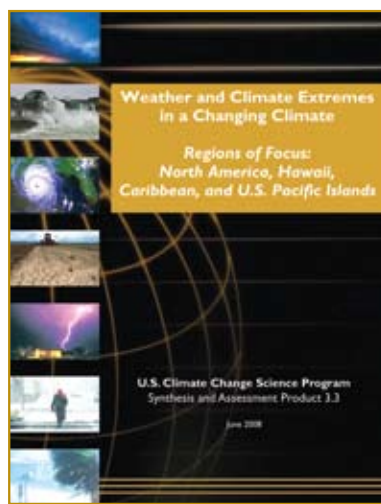


Reflected sunlight measurements corrected using direct measurements made over a barren desert location (Source: Rao and Chen, *Int. J. Remote Sens.*, 1995).

change and variability, maintain our economic viability, and improve the security and well-being of the public.

U.S. CLIMATE CHANGE SCIENCE PROGRAM

In 2008, the Center participated in the development of two major reports for the CCSP. In June, *Synthesis and Assessment Product 3.3: Weather and Climate Extremes in*



a Changing Climate, was published. The product, focusing on North America, Hawaii, the Caribbean, and the U.S. Pacific Islands, provided an overview of the impacts and challenges related to changes in extreme weather and climate events over the past 50 years. For example, in recent decades most of North America has been experiencing more

unusually hot days and nights, fewer unusually cold days and nights, and fewer frost days. Heavy downpours have become more frequent and intense. Droughts are becoming more severe in some regions, though there are no clear trends for North America as a whole.

To improve accessibility to such important findings in this and 20 other CCSP Synthesis and Assessment Product



reports, NCDC scientists and graphics and other support personnel contributed in 2008 to the development of *Global Climate Change Impacts in the United States*. This report summarizes the science of climate change and the impacts of climate change on the United States, now and in the future. The report discusses climate-related impacts for various societal and environmental sectors and regions across the nation, with the goal of better informing public and private decision making at all levels. Final publication is anticipated by June 2009.

NESDIS AND NCDC REORGANIZATION

Following two years of strategic visioning and discussion by management, employees, and user groups, NCDC took a major step in early 2008 toward a reorganization of center functions. By summer 2008, the Center moved to a functional organization including four divisions—climate services, satellite applications, scientific services, and support services. This structure was established to meet emerging needs for sector-based climate services, as well as the integration of research and operations in the development and maintenance of key climate data sets and quality control techniques. The structure also anticipates the rapidly growing importance of CDRs and scientific stewardship practices that are prerequisite to the vitality of a 21st century environmental data archive. The NCDC reorganization was incorporated

into a broader National Environmental Satellite, Data, and Information Service (NESDIS) reorganization in fall 2008. The reorganization is expected to be approved in conjunction with other realignment actions in 2009.

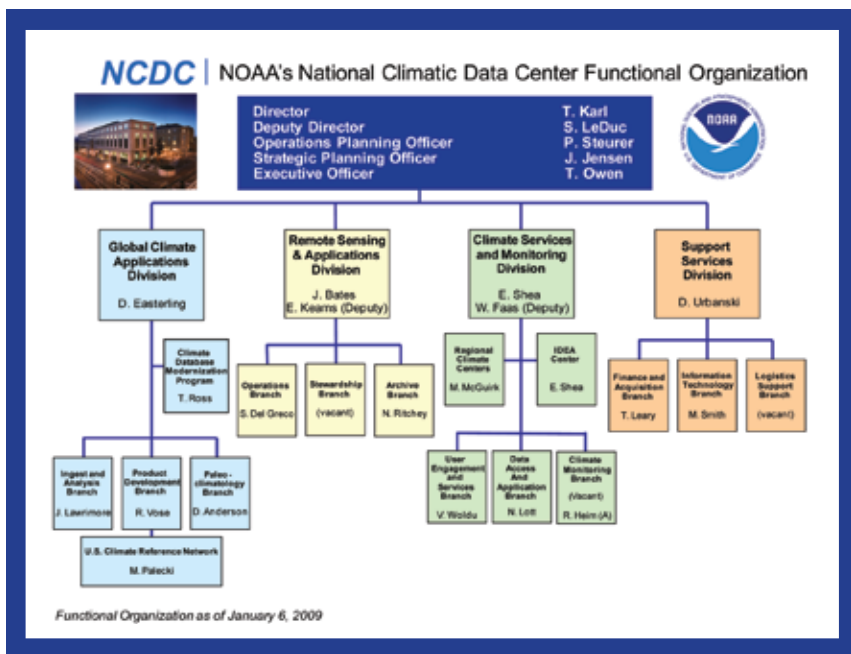
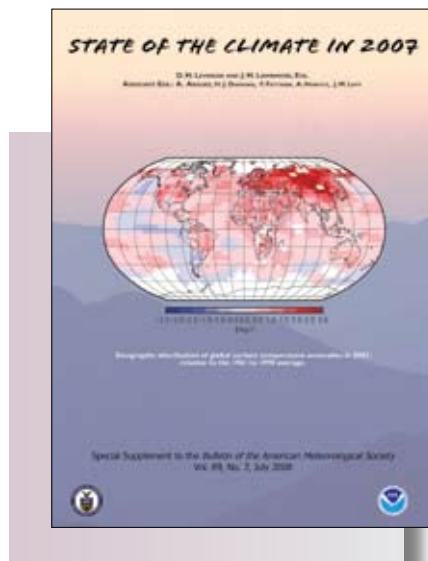
COMPLETION OF THE U.S. STATE OF THE CLIMATE REPORT

In support of NOAA's mission to understand changes in the Earth's environment, monitoring and reporting on the state of the Earth's climate is one of NCDC's most visible activities.

NCDC's monthly, seasonal, and annual state of the climate reports are widely disseminated and referenced by scientists, international organizations, and the media, among others. In FY2008, NCDC published the *State of the Climate in 2007* annual report as part of the July 2008 issue of the *Bulletin of the American*

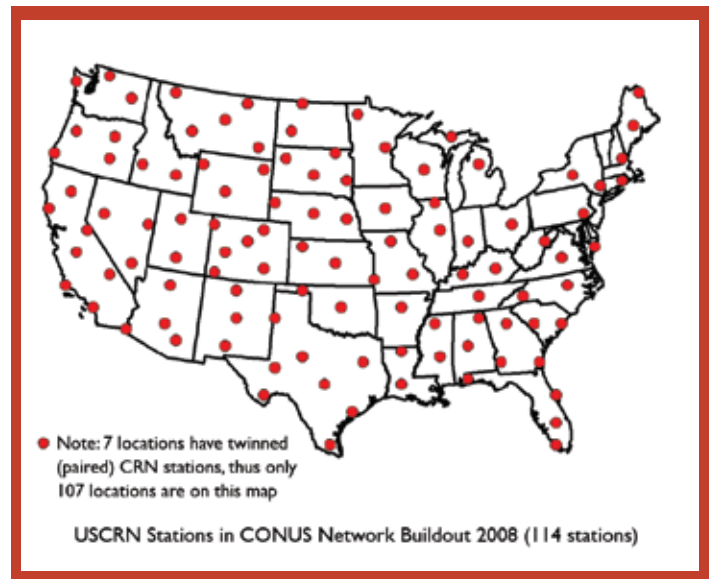
Meteorological Society. This represents the eighteenth state of the climate annual report that has been produced by NCDC, the twelfth year it has appeared in the *Bulletin*, and the third year it has been published as a separate supplementary document. The annual state of the climate report documents significant climate events that occurred during the year and provides summaries of global and regional climate conditions, as well as placing those conditions into historical context.

The scope of this report has increased substantially in recent years. The 2007 publication contained contributions from 235 authors representing 58 countries, an increase of 76 authors and 25 countries from the 2006 report and over twice the number from the 2005 report. These scientists distilled millions of environmental observations into meaningful synopses of 21 Essential Climate Variables (such as air temperature, ocean circulation, and snow cover), providing information that is critical to expanding our understanding of the current status and



variable nature of the Earth's climate system. The report, along with those of previous years, is available online at <http://www.ncdc.noaa.gov/oa/climate/research/state-of-climate/>.

The State of the Climate Annual Report is but one component of NCDC's efforts to monitor and assess the climate conditions that impact society and nature. NCDC continually monitors climate conditions from around the globe, as well as reporting on notable climate events. In an effort to reduce adverse socioeconomic or environmental impacts from extreme climate events, NCDC provides special focus on atmospheric phenomena that have an unusually large impact on the United States. In addition to regular monthly and seasonal reports regarding climate conditions, tropical storms, wildfires, tornadoes, and climatic hazards, NCDC produced a comprehensive special report in 2008 on the record-setting flooding that inundated the midwestern United States during the first half of June. This event was comparable with the infamous Midwest flooding of 1993. NCDC's climatological, hydrological, and data analysis expertise was combined with that of experts from the Midwest RCC, the U.S. Geological Survey (USGS), and the NOAA NWS to produce this assessment of an event that set over 1,100 daily, 78 June, and 15 all-time 24-hour precipitation records; exceeded 500-year flood stages on many rivers; and had an economic impact estimated at \$17 billion.

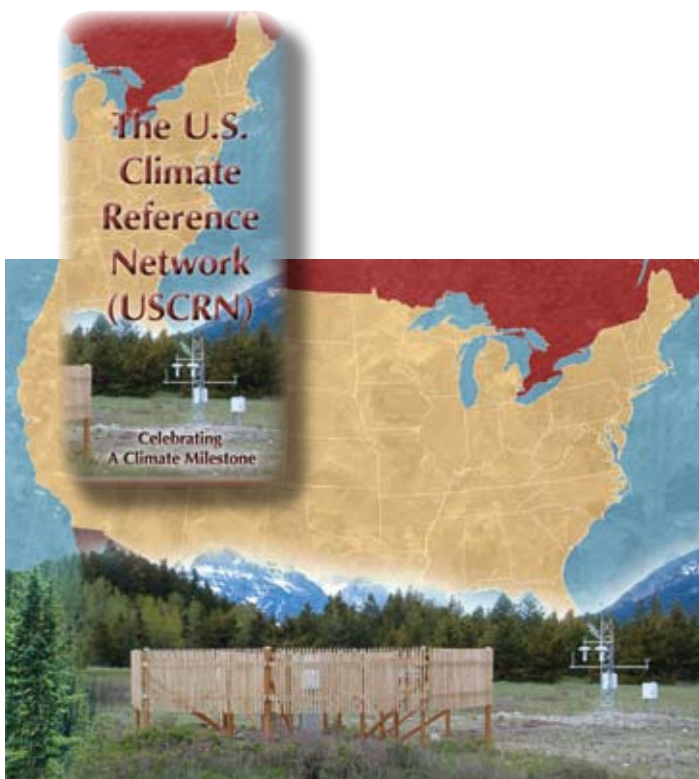


OBSERVING NETWORKS

U.S. CLIMATE REFERENCE NETWORK

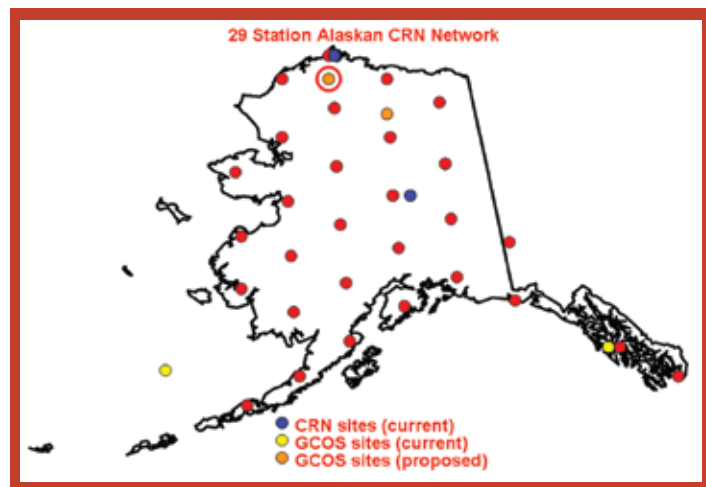
NCDC, in conjunction with NOAA's Air Resources Laboratory's ATDD in Oak Ridge, TN, achieved a significant milestone in September 2008 with the installation and commissioning of the final site in the 114 USCRN station configuration for the continental United States in Coos Bay, OR. The USCRN fulfills the need for long-term sustainable and robust climate observations that are necessary to document long-term climate change trends for the nation. However, that significant milestone does not represent the completion of the program. The challenge now is to continue the high level of annual maintenance, equipment refresh, and continued improvements in quality control and assurance that will insure that the USCRN can continue to document climate change, on a national scale, over the next 50 to 100 years. Additionally, the program is evolving in a number of areas as follows:

- Beginning the installation of soil moisture/soil temperature and relative humidity instrumentation in support of the National Integrated Drought Information System (NIDIS),
- Commencing a formal expansion into the state of Alaska with the eventual implementation of 29 additional stations over the next several years,
- Continuing bilateral cooperation with Environment Canada concerning the development and testing of new sensors and related software algorithms, and
- Developing an in-house USCRN Science Project promoting the use of CRN observations in climate research at NCDC and externally.



Related to the expansion of the USCRN into Alaska, NCDC in partnership with NOAA's NWS Alaska Region Headquarters (ARH), held a workshop in Anchorage, AK, in May 2008 that focused on plans to expand the USCRN into Alaska. Four prototype USCRN sites were installed in Alaska between 2002 and 2005 via the GCOS Program to provide experience with CRN technology in this unique environment. The intent, based on available resources, is to install and commission 29 additional USCRN sites in Alaska over the next several years. NCDC and ARH have established partnerships with federal agencies in the state [e.g., the USGS and the U.S. Department of Agriculture (USDA)], Environment Canada (with which NCDC has a bilateral climate observing agreement), and the University of Alaska, Fairbanks, to plan for potential USCRN sites in Alaska. The first new site is slated for installation in 2009 at the USGS's Shumagin Geomagnetic Observatory site in Sand Point, AK. Presentations from the workshop can be found online at <[ftp://dossier.ogp.noaa.gov/USCRN-in-Alaska-Workshop-May2008](http://dossier.ogp.noaa.gov/USCRN-in-Alaska-Workshop-May2008)>.

In 2005, two prototype USCRN stations were installed at Mauna Loa and Hilo on the Big Island of Hawaii; these two sites are both operating and providing continuous data



today. An optimal USCRN configuration in Hawaii would encompass 10 stations state-wide. In addition, in 2005, a station survey was done for installing an eventual USCRN station in American Samoa. Some logistics issues vstill need to be worked out before installation of that station can move forward. Optimally, three more sites would be required (one each) in Guam, Kwajalein, and Wake Island. Other possibilities that have not been fully investigated still exist for locations such as the Commonwealth of the Northern Mariana Islands. Funding for USCRN sites in the Pacific is being planned through the U.S. GCOS Program.

As for Puerto Rico and the Virgin Islands, an optimal distribution of six sites (four in Puerto Rico and two in the Virgin Islands) would be required to characterize climate in those areas. To date, no planning has been done for any installations there except for some collaborative work with the Smithsonian Tropical Research Institute (STRI). NCDC and STRI are about to enter into a Memorandum of Agreement that would allow us to collaborate in installing and maintaining up to 20 sites at STRI tropical research areas around the globe over the next 10 years. The U.S. GCOS Program is investigating an initial installation of a USCRN station at the STRI site at the Luquillo Experimental Forest Station.

THE U.S. HISTORICAL CLIMATOLOGY NETWORK MODERNIZATION PROGRAM

Since the primary mission of the USCRN is to determine national trends, a regional observing network is also in the process of being developed by NOAA, and while the program is presently managed by the NWS, NCDC is a significant partner in that effort.

The USHCN-M Program, as it is known, involves the installation of 1,000 stations on an evenly spaced grid making high quality temperature and precipitation observations that more fully align their monitoring capability with the GCOS Climate Monitoring Principles.

Beginning with the Project's Charter, drawn up by the Executive Steering Committee (ESC) and approved by the NOAA Observing Systems Council in November, 2007, the USHCN-M project management¹ has combined the talents of three Line Organizations, [the Office of Oceanic and Atmospheric Research (OAR), NESDIS, and NWS and Goal Team members].

¹ See <<https://bestpractices.nws.noaa.gov/contents/hcnm/index.php>>.



Global STRI Sites for Potential USCRN Stations

Integrated Work Teams were formed at the Project's kickoff in December 2007. NCDC took leadership roles in the Site Design and Development, Operations and Maintenance, and Information Technology (IT) teams, involving approximately 100 people. By February 2008, the ESC had approved the draft designs of all three Working Teams, had decided to base USHCN-M on the core USCRN temperature and precipitation sensor technology, and had scheduled implementation of two Pilot activities.

Precise plans for implementing USHCN-M stations are now focused on a Pilot implementation of 141 sites in the Southwest Climate Region (AZ, CO, NM, UT) where drought over the last decade rivals any other of the past century and complex topography confounds interpretation of national trends. A second Pilot for Commissioning builds on the model of 17 HCN-M sites which the ATDD has installed in Alabama since 2006. The key component of the USHCN-M is interoperability with USCRN (e.g. siting, instrumentation, and data management), as reflected in the Level 1 Requirements Document. And key to that, is leveraging existing contracts with NCDC's partners, the RCCs, and OAR/ATDD.

Beginning in April 2008, NCDC arranged contracts with its RCCs² to assist in site survey and associated siting activities. An important consideration was scaling the processes developed for USCRN to HCN-M, given that in the Pilot area alone, more HCN-M stations would be installed than in the entire CRN project. The Southern

RCC established a Web-based Mapping tool³ to aid in the selection of candidate sites showing the location of all federal and state observing stations, with reference to the evenly spaced grid points (sometimes called fuzzy dots), and layering land features, federal and state lands, and other pertinent features. The Western RCC established a Web-based tool for the Site Survey⁴ package to enable a cross-LO team to evaluate and select sites for installation. By December 2008, 100 desk and field surveys had been conducted and 20 sites had been selected and approved for installation.

Even while the surveys were just beginning, the Site Design, IT, and Operations and Maintenance Teams also made great progress. In September 2008, the final System Design was approved, and several options were put forward for maintenance strategy.

Working concurrently, great progress was also made in the Commissioning Pilot. In May 2008, the Commissioning Plan was drafted. Following that, a Commission Evaluation was conducted during August 2008 for the sites in Alabama. Remarkably, the IT Certification and Accreditation was awarded.

Adding to NCDC's team of experts, the NWS has placed two contractors at NCDC, a software engineer and a professional geographer. The geographer aids with the Site Survey process. The software engineer is working to increase the throughput of CRN data to the normal distribution channels used by NCDC's customers. Together with NWS and OAR's Earth System Research Laboratory, NCDC is working on a way of making available near-real-time CRN data. In this way, the distribution channel of USHCN-M data will be prepared even before the stations are installed.

No doubt in part because the project leveraged NCDC's expertise built in the USCRN project, by year's end, all the project's components were on time and in budget. Site License Agreements are more complex and expensive than with the USCRN sites.

2 See <<http://www.ncdc.noaa.gov/oa/climate/regionalclimatecenters.html>>.

3 See <<http://storm.srcc.lsu.edu/hcnmap/map.htm>>.

4 See <<http://www.wrcc.dri.edu/hcn/>>.

PARTNERS

REGIONAL CLIMATE CENTERS

In April 2008, the RCCs entered the second of a three year contract administered by NCDC and funded by Congress. The contract calls for Basic and Advanced climate services funded at a level of \$525,000 per RCC and additional monies for Supplemental Climate Services, which vary by RCC. In total, the RCCs supported NCDC's missions to an order of \$6 million.

RCCs became part of NCDC's Monthly State of the Climate Report this past year. Each Regional Climatologist routinely provided Regional State of the Climate reports to the Climate Monitoring Branch. RCC provided dozens of media interview, print and television, to their respective news media, giving more exposure to NCDC's products. RCCs also participated fully in the NIDIS portal.

Working through the RCCs, NCDC continued to expand its climate data delivery, storage, and access services to other federal partners in the Departments of Interior, Agriculture, and Homeland Security. There were a number of projects undertaken by RCCs in collaboration with the State Climate offices, and other Federal agencies.

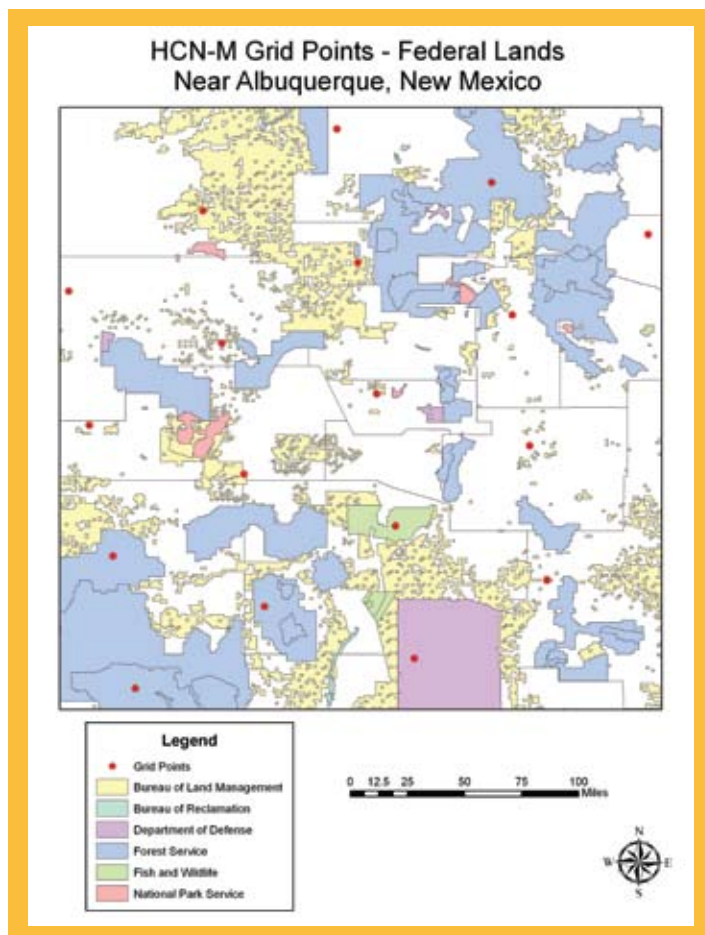
For the Department of Interior's National Park Service (NPS), the Western RCC developed detailed climate data inventories of all of the (approximately) 285 National

Parks and Monuments that are considered "Resource Parks" by the NPS. All of the 32 reports (each about 100 pages long) can be found online⁵. For the Bureau of Land Management, the RCCs began managing the data and metadata for the Remote Automated Weather Stations. The RCC supported the USDA's U.S. Forest Service and National Resource Conservation Service

with development in the agriculture version of the Applied Climate Information System (ACIS, AgACIS). RCCs

provided expertise and the AgACIS system provided operational support delivering climate data for the users of the electronic Field Office Technical Guide, climate data for assessment for the Interagency Fire Center, and data for crop assessments and yield forecasts. For the Department of Homeland Security's (DHS's) Federal Emergency Management Agency, the Southern RCC installed portable weather stations following hurricanes in the South and participated on the Governor's task team for emergency management in natural disasters.

Among other noteworthy accomplishments this year is further development of WxCoderIII. Over 2,500 National Cooperative Observer Network (COOP) stations' data were entered into WxCoderIII. Developed by the Western RCC, a backup system is also being installed in the High Plains RCC. WxCoderIII writes COOP data onto the NWS Advanced Weather Interactive Processing System, and delivers a datafile to NCDC for inclusion into the National Archive. With this, NCDC has begun to schedule a paperless environment with the NWS.



⁵ See <www.wrcc.edu.edu/nps>.

Other systems developed by the RCCs, with NCDC and NWS funding, continued to increase in efficiency, such as ACIS, Datzilla, NowData, and ThreadEx.

At year's end, the RCCs were invited to meet with the Presidential Elect Transition Team wherein they discussed the valuable services that NCDC is able to provide through them to important sectors of the economy and to a wide range of federal partners.

AMERICAN ASSOCIATION OF STATE CLIMATOLOGISTS

NCDC continued its partnership with the American Association of State Climatologist (AASC)⁶. At year's end, all but 12 states had signed Memorandums of Understanding (MOUs) with NCDC, indicating that they had completed all the requirements as AASC-Recognized State Climate Offices (ARSCOs). In this last year, the AASC Executive Council redoubled its efforts to provide accurate information on every ARSCO. Uniquely this year, NCDC found that states were beginning to identify both a Director of the State Climate Office and also the State Climatologist. The state of Alaska became the first state to have both.

The AASC Annual Meeting, held in Burlington, VT in July 2008, attracted the attention of the Deputy Administrators of NESDIS and NWS, several Senior Executive Service personnel, and the Climate Goal Team lead. NCDC

prepared the keynote presentation on AASC's partnership role in National Climate Services.

At the AASC annual meeting, NCDC announced a new grant application process for the ARSCOs, which increased the State Climate Exchange Program (SCEP) from \$10,000 to \$100,000. Funded by NESDIS and the NWS, this year's SCEP was intended to be used for three items: monthly state-of-the-climate reporting by states to NCDC's Monitoring Branch, economic impacts of Climate Events, and analysis of the USCRN and the modernization of the USHCN-M data. In all, 30 states applied for the research projects. As a test case of the three-tiered climate services (at national, regional, and state levels) each ARSCO's proposal was reviewed and is being moderated by the respective RCC. There has been an unsurprising increase in cooperation between ARSCOs and NCDC.

NATIONAL WEATHER SERVICE

NCDC worked extensively with the NWS's Climate Data Services Division in collaborative projects with Regional Climate Service Program Managers across the nation. NCDC instructed NWS personnel, including Climate Focal Points from the 122 Warning and Forecast Offices in data stewardship, metadata, station siting, and quality control techniques. NCDC made numerous presentations to Regional meetings on Climate Change and Applied Climatology.

NCDC served on the planning commission for the National Climate Services, helping to define existing capabilities and future needs. This year, the NCDC customer service division began collaboration with NWS to respond to inquiries from the public that are posted on the NWS Climate Services web pages.

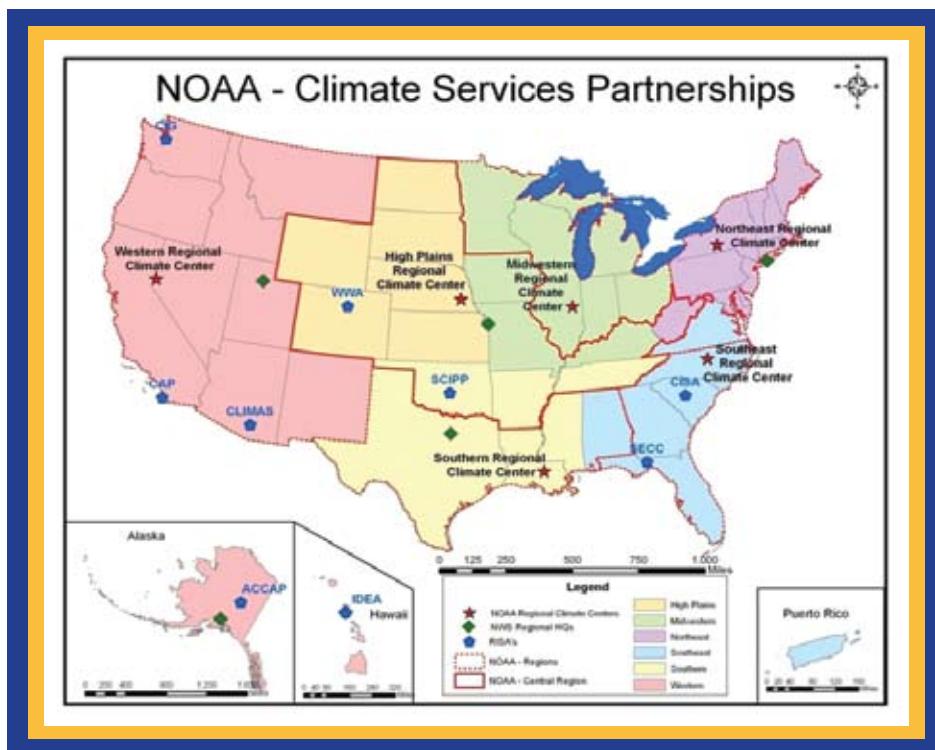
UNIVERSITY OF NORTH CAROLINA, ASHEVILLE

The University of North Carolina Asheville (UNCA) received grants totaling \$185,000 from NCDC for the period of July 2007 to 2009. The funded program covered three separate, but interacting, elements: course development, research, and development of outreach tools. UNCA personnel met with NCDC Division Chiefs on a bimonthly basis starting August 2008.



AASC State Climatologists

⁶ See <<http://www.stateclimate.org/>>.



DEVELOPMENT OF OUTREACH TOOLS

NCDC continued its collaboration with UNCA on the development of the Hazards Risks Assessment Tool and visualization applications on the Touch Table. Working with the North Carolina Geographic Information Systems (GIS) Disaster Team, the National Environmental Modeling and Analysis Center, and the Renaissance Computing Institute (RENCI) at Chapel Hill, NCDC collaborated in providing decision support tools for the state of North Carolina tied to weather and climate. Together we are creating a toolbox that volunteers can access to provide GIS support following a major hurricane or similar natural disaster. This past year saw the establishment of an Applied Visualization Lab at the RENCI campus of UNCA.

NCDC participated in an Applied

Vis Conference at Enka in January. Clips from the NCDC media library were used in a movie production *Water in WNC—the Drought and Power Connection*. This premiered at the Tennessee Valley Corridor Southeast Partnership Event held at the Grove Park Inn in November 2008.

NCDC is coordinating further partnerships of a UNCA-produced Web Cam Viewer, for use by NWS offices. Other developments in outreach tools included applying climate and weather issues directly to western North Carolina by using a variety of tools including: the creation of movies and graphics for NOAA's StormCenter Touch Table, Immersive Theater Movies (NOAA National Education and Outreach has ordered seven domes), Decision Theater, web content, and materials for the RENCI outreach van.

NCDC INTERNATIONAL ACTIVITIES

Climate science and related data management activities are by their nature international. NCDC is the world's largest active archive of weather data. The Center produces numerous climate publications and responds to data

COURSE DEVELOPMENT

Under this grant, UNCA developed a Climate and Culture master's level course—one intended for non-specialists—which was organized into major topic areas related to the interplay of climate patterns with human responses to environmental vulnerability and sustainability. NCDC scientists lectured some of the class topics including sudden climate change, the impact of sudden climate change on past cultures, and the system of oceanic-atmospheric interplay that influences human activity.

RESEARCH

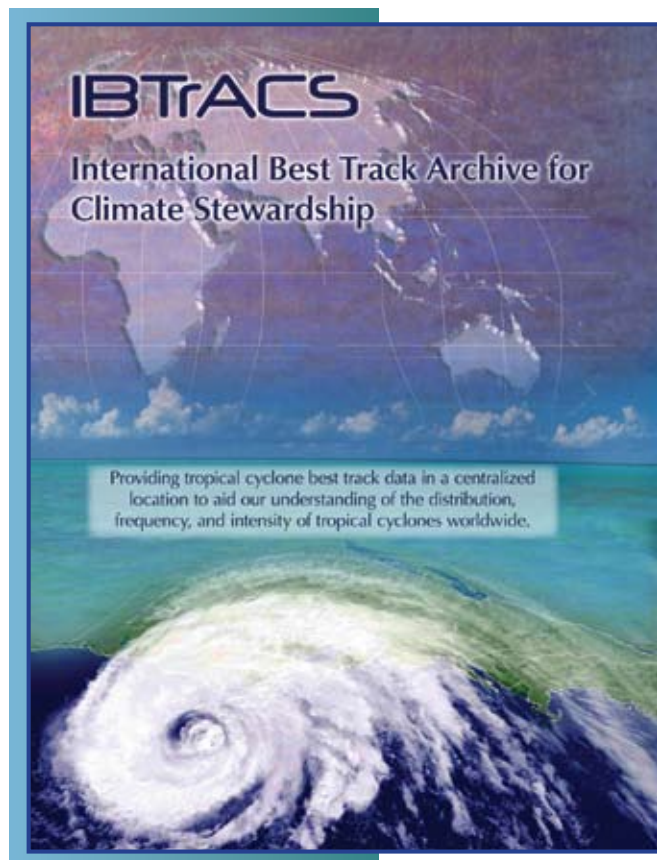
Through an Intergovernmental Personnel Act, NCDC and UNCA wrote a Handbook for Professional Planners, designed to help planners mitigate and adapt to the effect of climate and climate change at urban and regional levels. The draft manuscript, called *Planning for Climate Change*, was distributed for peer review in September 2008. The American Planning Association (with its membership of 80,000) plans to publish the Handbook in 2009. The President-Elect Transition Team requested an early copy for the President's Office of Urban Policy.

A Faculty Fellowship was awarded to study the mechanisms of change among a population in response to climate change and to evaluate the effectiveness of outreach tools being developed by UNCA. Five undergraduate interns were assigned research tasks during the summer and fall of 2008.



requests from all over the world. Additionally, NCDC operates both the WDC for Meteorology⁷, as well as the WDC for Paleoclimatology⁸, which are key components of the international WDC system⁹ designed to aid in the international exchange and collaboration of science data in a number of scientific disciplines. Under the auspices of the WDC for Meteorology an NCDC team is working with partners in several countries as well as the World Meteorological Organization (WMO) to develop the International Best Track Archive for Climate Stewardship (IBTrACS). The goal of IBTrACS is to compile tropical cyclone best track data from 11 forecast centers spanning the globe from Australia to Japan to the United States, producing a unified global best track dataset. Best track data include the position, maximum sustained winds, and minimum central pressure of a tropical cyclone at six hour intervals. Despite the significant impact of tropical cyclones on society and natural systems, there was no central repository for global best track data prior to the development of IBTrACS. A workshop is planned for May 2009 at NCDC and more information can be found on the IBTrACS page at <<http://www.ncdc.noaa.gov/oa/ibtracs/>>.

Work continues on the GOSIC which provides access to data, metadata, products, and information on behalf of the



7 <<http://www.ncdc.noaa.gov/oa/wdc/index.php>>

8 <<http://www.ncdc.noaa.gov/paleo/paleo.html>>

9 <<http://www.ngdc.noaa.gov/wdc/wdcmain.shtml>>

various Global Observing Systems (*e.g.*, GCOS) as well as some of their regional sub-programs such as the Regional Associations that are part of the Global Ocean Observing System (GOOS). The GOSIC was registered this year as a community portal component of the Global Earth Observations System of Systems (GEOSS) and its data registry is now a data access service on the overall GEOSS Portal at <http://www.geoportal.org/web/guest/geo_home>. The GOSIC supported the Pacific Island region with the development of Joomla based web sites for various Pacific regional observing efforts. Finally, the GOSIC also developed a web page for the GOOS Regional Alliances to enable data and information exchange through the GOSIC portal.

A considerable amount of work is done at NCDC on a number of key bilateral agreements that are either managed at the NESDIS, NOAA, or State Department level. Noteworthy activities during FY2008 took place with our partners in Australia, Canada, New Zealand, Russia, and the United Kingdom. Considerable cross-border cooperation and coordination between NCDC and our counterparts in Environment Canada's Meteorological Service of Canada (MSC) continue with respect to bilateral sensor testing and development of new algorithms for the USCRN program. A Canadian Reference Climate Network (RCN) station is now installed at a testbed at the USGS's Earth Resources Observation and Science Data Center in Sioux Falls, SD, and considerable work focusing on automated snow observing is a key activity there. In addition, MSC personnel were key participants in a USCRN workshop that was held in Anchorage, AK in May 2008; there are many lessons learned from installing RCN stations just across the border from Alaska in Canada, and their participation was critical and quite valuable to all participants. Coupled with work on the North American Drought Monitor, NCDC's work with Canada is a key international activity at NCDC.

An MOU was also signed between NCDC and the Hadley Centre of the UK Met Office. NCDC and the Hadley Centre have a long history of cooperation and collaboration, and the purpose of this MOU was to enhance and maximize program capabilities in both countries; encourage joint efforts to resolve common problems; and promote compatibility in the collection, analysis, archival, and dissemination of data so that the data can be readily accessed, analyzed, and integrated as desired.

NCDC's high-level bilateral meetings with Russia's Roshydromet was on continuing engagement *vis-à-vis* data exchange. This activity was specifically encouraged by

the WMO Permanent Representatives of the United States and Russia, who is also President of the WMO. A meeting between NOAA and Roshydromet held in Washington, DC in April 2008 encouraged renewed dialog between the two organizations in order to develop new data exchanges and new research projects. NCDC is leading this effort with active participation from the National Snow and Ice Data Center, the Oak Ridge National Laboratory, as well as the National Centers for Atmospheric Research (NCAR). These efforts were followed up with a workshop held in Obninsk, Russia, in November 2008. The results of this workshop led to the increased availability and improvement in the value of data sets exchanged between the United States and Russia. This is particularly true in the context of supporting research activities associated with the International Polar Year. Plans continue to work on installing two USCRN stations in the Russian Arctic.



As the host for the GCOS Program office the center continued to coordinate to improve surface and upper air observations (particularly reference observations) on both a national and international basis. A highlight in 2008 was the

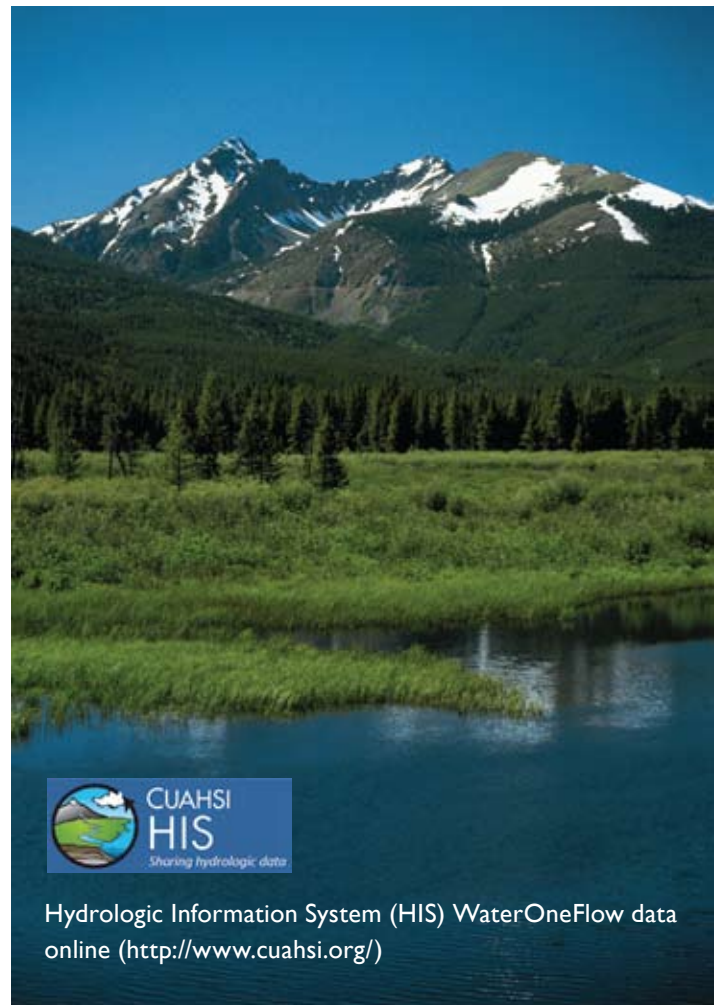
production, under the auspices of CCSP, of *The United States National Report on Systematic Observations for Climate for 2008* which can be found on the CCSP web site at <http://www.climate-science.gov/Library/UNFCCC-report.htm>. All Annex I (or industrialized nations) were required under the United Nations Framework Convention for Climate Change (UNFCCC) to have this report completed and submitted to the UNFCCC by September 15, 2008. A lot of work has also gone into spearheading and coordinating the development of a new GCOS Reference Upper Air Network (GRUAN) to provide climate quality upper air data not currently available. NCDC has been a prime supporter and backer of the GRUAN and in concert with partners from other parts of NOAA, the Department of Energy, and NCAR, drafted a plan for the U.S. implementation of the GRUAN beginning in 2009.

COLLABORATION WITH CONSORTIUM OF UNIVERSITIES FOR THE ADVANCEMENT OF HYDROLOGIC SCIENCE, INC.

With support from the National Science Foundation, the collaboration with Consortium of Universities

for the Advancement of Hydrologic Science (CUAHSI) has developed a Hydrologic Information System (HIS) for the discovery and delivery of water-related data from a variety of government agencies, as well as the publication and archiving of the data from the academic research community. The CUAHSI HIS project has been operational since April 2004, led by academic hydrologists collaborating with the San Diego Supercomputer Center as a technology partner.

Since NCDC is a major provider of NOAA water-related data, the success of HIS depended upon cooperation and collaboration between NCDC and CUAHSI. The basis for this collaboration is the common interest of both NCDC and CUAHSI to make hydrologic data and products readily available. The USGS National Water Information System is also a partner in this effort. As a result of this partnership, WaterOneFlow Web Services are now operational and allow users to query data from multiple systems for their area of interest. For example, users can request streamflow data from USGS and rainfall data from NCDC via a single Web Service-enabled interface. This also serves as a prototype for future expansion of these types of services.

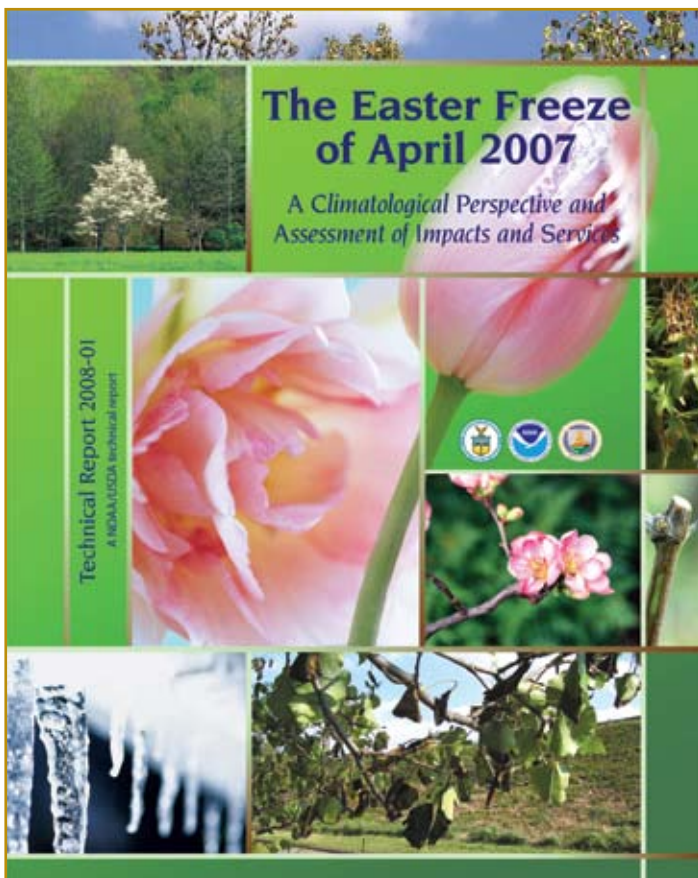


DATA CENTER INFRASTRUCTURE

NOAA VIRTUAL DATA SYSTEMS

NVDS is comprised of Climate Data Online Services (e.g., Quality Controlled Local Climatological Data, etc.), GIS Services, an Image and Publications System, the NESDIS E-government System, and NEXRAD Radar Data Services, among others areas. In FY2008, NCDC delivered over 338 terabytes of climate data online, a seven percent increase over FY2007. This represents the continued growth of satellite, *in situ*, radar, and model data. Over 1.8 petabytes of data are now accessible from the NCDC's website. To manage this increased data availability and demand for data, NCDC continues to implement new hardware upgrades to manage this growing online resource.

NVDS also provides access to numerous publications and reports, such as a joint NOAA/USDA technical report released in 2008 regarding the severe April 2007 freeze event. The report includes contributions by the USDA; NOAA's NCDC, NWS, and Climate Prediction Center (CPC); and various State and Regional Climate Centers.



It describes in detail the event which resulted in over \$2 billion in agricultural losses.

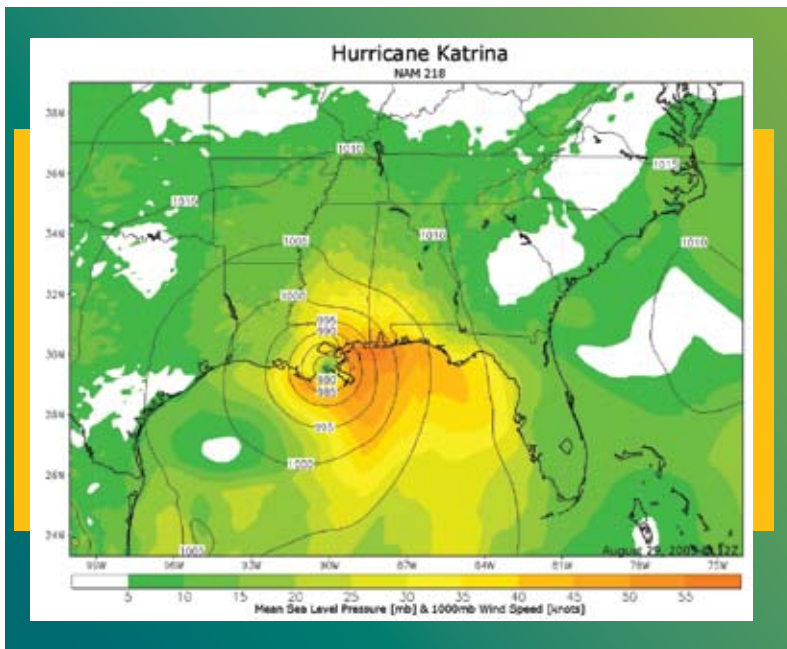
NATIONAL OPERATIONAL MODEL ARCHIVE AND DISTRIBUTION SYSTEM

NOMADS (<http://nomds.ncdc.noaa.gov>) is a distributed Web Service providing interoperable and standards-based access to climate and weather model input and output. Over the last two years, and in close coordination with NCDC NOMADS, the NWS implemented the R/T NOMADS: a real-time operational component for NOMADS. Permitting access from the real time to historical R/T NOMADS provides high availability access to real-time NWS Numerical Weather Prediction data using the same access technologies as the archive component at NCDC. NOMADS is also a contributing partner and co-chair to the GEOSS Architecture Implementation Pilot (AIP-2). Finally, the NOMADS collaboration continues to be adopted throughout the community as evidenced by the recent development for an Ocean NOMADS by NOAA's National Ocean Data Center (NODC) that will service ocean models and associated observational data.

NOMADS continues to address system and data access measures that address the 2006 report by the National Academies NRC, Board of Atmospheric Science and Climate which concluded: "NOMADS should be maintained and extended to include (a) long-term archives of global and regional ensemble forecasting systems at their native resolution, and (b) re-forecast datasets to facilitate post-processing".

At the request of the World Climate Research Programme and The Observing System Research and Predictability Experiment (THORPEX) Interactive Grand Global Ensemble (TIGGE) project, NOMADS is helping to develop international distributed access to the modeling centers suite of five-dimensional model ensemble output. TIGGE is an international effort to accelerate improvements in the accuracy of one-day to two-week and beyond high-impact weather forecasts through the use of ensemble prediction and distributed access to model archives. NOMADS also leads the TIGGE Task for the Group on Earth Observations.

Finally, the NOAA Science Advisory Board has requested NOMADS provide access to the next suite of NOAA's climate and weather reanalysis datasets. Availability to the NCEP Coupled Climate Forecast System Reanalysis dataset is expected through NOMADS by late 2009; while



the Earth System Research Laboratory's Climate of the 20th Century will be available by mid-2009. For these and future reanalysis efforts, NOMADS developed an online and interactive user community forum to solicit user access preferences to these massive datasets. For further information please see <<http://nomads.ncdc.noaa.gov/NOAAREanalysis>>.

COMPREHENSIVE LARGE ARRAY-DATA STEWARDSHIP SYSTEM

The environmental stewardship mission of NESDIS requires NESDIS to acquire, archive, and disseminate environmental data. NESDIS has been acquiring data for more than 30 years, from a variety of *in situ* and remote sensing observing systems throughout NOAA and from a number of NOAA's partners. NESDIS foresees significant growth in both the data volume and the user population for the data, and has therefore initiated an effort to evolve current technologies to meet these future needs. This effort resulted in the development, fielding, and ongoing evolution of CLASS.

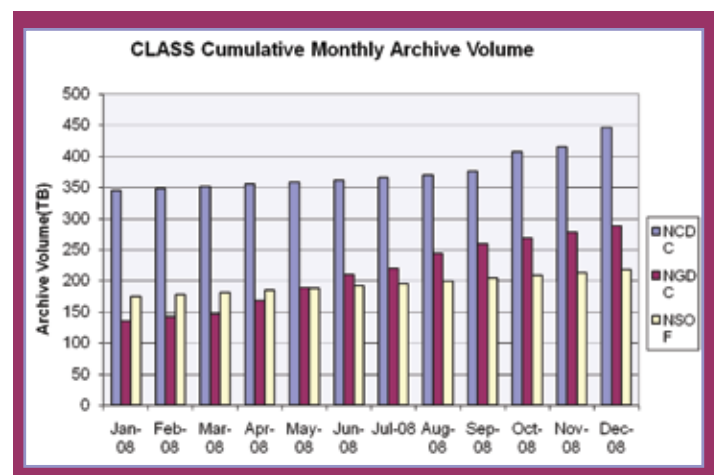
CLASS consists of three operational nodes located in Suitland, MD, at NOAA's Satellite Operations Facility (NSOF); in Boulder, CO, at the National Geophysical Data Center (NGDC); and in Asheville, NC, at NCDC. NOAA's data centers and their archive IT infrastructure are evolving to meet the changing needs of customers and to take advantage of technology improvements. One example is the mirroring of data between the data center nodes to enhance data survivability and availability should problems be encountered at one node. The CLASS IT data

storage infrastructure includes a mix of storage area network (SAN) disk arrays and tape robotics systems. Current data storage systems at the NCDC node include a 384 terabyte-capacity SAN and a newly installed tape robotics library with slots for 10,000 tape cartridges. Storage capacity of the new tape library is four petabytes with current tape, growing to eight petabytes with the next generation tape cartridge.

The CLASS development effort involves several different government and contractor groups in various geographic locations, managed by the NESDIS Office of Systems Development. An important component of the system evolution is the transfer of the CLASS IT ingest, archive, and access system from development to operations within NOAA's data centers. This transition will allow

for improved efficiency and customer service as the data centers can take better advantage of the common services the CLASS system provides to fulfill their missions.

A CLASS Operations and Planning Board consisting of the data center directors, NESDIS Chief Information Officer (CIO), and CLASS program manager was formed to oversee the transition from development to operations which has already begun at NCDC, NGDC, and NSOF. The volume of data encompassed by CLASS operations at these sites currently exceeds 1.15 petabytes stored at the data centers via CLASS IT infrastructure. The volume of data archived using CLASS has grown during 2008 by 30 percent, 112 percent, and 25 percent at NCDC, NGDC, and NSOF, respectively. Current trends in CLASS-based storage in the archives will continue for the near future as new data sets are identified by the data centers for ingest. These trends will be significantly increased by the inclusion of data streams from new satellite missions in the near future, including NPP (2011), NPOESS (2014), and GOES-R (2015).



THE NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

The U.S. Drought Portal (USDP), a key component of NIDIS was established on the Internet as <<http://www.drought.gov>> in FY2008. This web portal is a clearinghouse for drought information and services currently geared toward addressing the needs of the general public and decision and policy makers primarily at the national level. The USDP is designed to answer such questions as what is the current state of drought, how is the drought impacting me, and what is the forecast for drought in the future?

Products from NOAA, as well as federal, state, and university partners, are included in the USDP to answer the above questions. Key components of the USDP include education and outreach, impacts information, and an integrated map viewer that allows visual overlaying of map layers to provide a custom depiction of drought depending on the needs of the user.

The USDP is a registered component of the GEOSS and is a data access and interoperability component of the GEOSS Architecture Phase 2 implementation project. It is also a key component of the Earth Science Information Partners water cluster. New services and products developed within the cluster are ensuring integration and interoperability with the USDP.

Post FY2008 changes to the USDP will look toward ease of navigation, expansion of mapping capabilities, and will focus on sub-national (regional) and international scales. Additionally, communities will be developed in the log-in section of the USDP to address administrative activities and to promote collaboration for NIDIS pilot projects.



EXPANDING AVAILABILITY OF PALEOCLIMATE DATA

Abrupt Climate Change

Paleoclimate data from ice cores, tree rings, and other natural recorders reveal that climate has not been stable over thousands of years. Instead, the paleoclimate evidence reveals that climate has changed abruptly from one state to another over periods as short as decades. Abrupt climate change could pose significant challenges to society in the future. A CCSP report titled *Abrupt Climate Change* was published in 2008, and described the current progress in research on abrupt climate change. NCDC archives and distributes data on abrupt climate change, including evidence of changes discussed in the CCSP report, such as rapid ice sheet melting, drought and hydrologic change, changes in the ocean circulation and its effect on climate, and changes in methane accumulating in frozen soils. NCDC also provides a primer on abrupt climate changes of the past, including links to data (<www.ncdc.noaa.gov/paleo/abrupt>).

Climate Reconstructions for the past 2,000 years

Understanding the long-term baseline of climate helps not only understand recent trends, but also contributes to understanding decadal and century-scale climate variability. NCDC operates the WDC for Paleoclimatology,

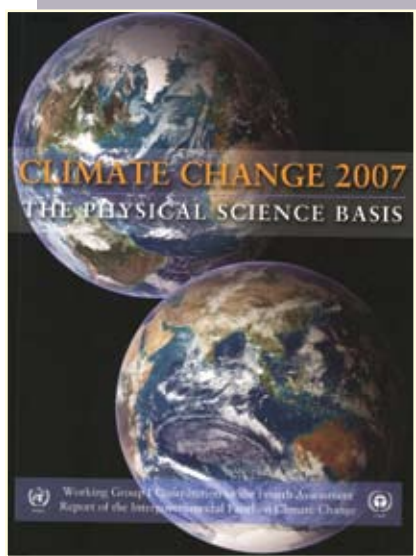


The homepage of the U.S. Drought Portal (drought.gov) highlighting state impacts of the current drought.

dedicated to sharing paleoclimate data, derived from tree rings, ice cores, and other natural recorders. Following the publication of the Intergovernmental Panel on Climate Change Assessment in 2007, and also the NRC Report, *Surface Temperature Reconstructions for the Last 2,000 Years*, the Center has archived dozens of new time series that document trends in temperature and other environmental variables over the past 2,000 years.

NOAA CLIMATE SERVICES PORTAL

With the rapid rise in development of Web technologies and various climate services across NOAA, there has been an increasing level of awareness of the need for working level discussions to focus climate services in at least two important technical areas: Portal Technologies and GIS Services. The reasons involve an interest in enhancing websites in response to customer requests, emerging user information and sectoral needs, and ongoing discussions across NOAA in the area of climate products and services.

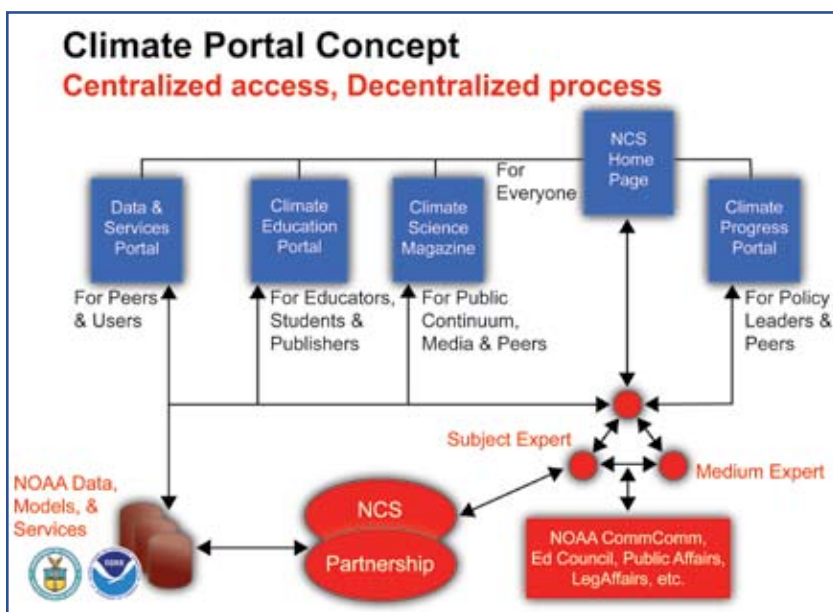


To address these needs, the first NOAA Climate Services (NCS) Portal Workshop was held in August 2008 to conduct detailed technical discussions of a planned NCS Portal; to enhance the accessibility and usability of NOAA's climate data, products, and services by a variety of customers; and to allow more leveraging and interoperability of software development at various locations and enhance consistency in web-based climate services delivery across NOAA. Participants in the workshop included: NOAA Climate Program Office, NWS CPC, NWS Climate Services Division, NOAA and NWS CIOs, NOAA RCCs, NCDC, National Ocean Service (NOS) Coastal Services Center, NOAA Office of

Education, and Information Architect/Office of the Under Secretary. The following is a summary of the 2008 portal activities:

- June – A meeting was held in Asheville, NC with the interested players.
- August
 - A workshop was held in Asheville, NC to kick off project.
- September through November
 - Governance, Design, Data/Metadata, and User Testing Team efforts came underway.
 - Initial requirements were developed.
 - NCS Portal Charter was completed.
 - A presentation was made to the NOAA CIO Council.
- December
 - A workshop was held in Charleston, SC.
 - * An agreement on the prototype design was reached.
 - * Continued to work on the portal requirements document.
 - * Continued to work on the selected in-depth scenario case studies for the prototype: inundation and insurance/energy, drought and agriculture, and climate-interested/attentive public (magazine material).

During FY2009, Phase 1 of the NCS Portal will be developed, to focus on the most-used products and services.



GEOGRAPHIC INFORMATION SERVICES

NOAA also has a number of collaborative efforts ongoing in the GIS arena. NCDC has been working closely with NOAA's NOS Coastal Services Center in Charleston, SC in various activities, such as the ESRI Geoportal Toolkit (<http://www.esri.com/library/fliers/pdfs/gis-portal-toolkit.pdf>). Other collaborations include NCDC with the NWS's CPC and with the USGS.

A key goal in developing and deploying GIS technology is to provide users with simple map-based access to climate services. Users who are presented with data discovery options which flow into detailed product selection maps can search using standard tools or gazetteer (geographical dictionary search) functions. Each tabbed selection offers steps to help users progress through the system. A series of additional base map layers and data types provide companion information.

In addition to providing dynamic maps to access data, Web Map Services provide maps or images and Web Feature Services provide spatial features. These services may be used from Open Geospatial Consortium-compliant applications to directly access data and metadata. KMZ files used directly within 3D GIS viewers (*e.g.*, ArcExplorer, Google Earth) are also available for a number of datasets and products. Datasets and products are recorded in Federal Geographic Data Committee-compliant metadata which are harvested into catalog portals such as Geospatial One-Stop (<http://gos2.geodata.gov/wps/portal/gos>) and the Global Change Master Directory (<http://gcmd.nasa.gov/>).

Value-added layers and data types are also included which visually provide, for example: agricultural regions, coastal hazards, population density, global ecoregions and wetlands, state and regional climate divisions, National Transportation Atlas data, topography data, and visual imagery (*e.g.*, aerial photos). Gazetteers provide advanced search functions which allow users to rapidly isolate stations or areas of interest, such as by location name, zip code, river name, country, *etc.* (<http://gis.ncdc.noaa.gov>).

USER ENGAGEMENT

SECTOR ENGAGEMENT

During 2008, NCDC expanded their customer service activities to include sectoral user engagement. As a starting point, NCDC identified 11 user sectors which represent a majority of the users requesting climate data and information from NCDC. These sectors include: Agriculture, Civil Infrastructure, Coastal Hazards, Energy, Health, Insurance, Litigation, Marine and Coastal Ecosystems, Transportation, Tourism, and Water Resources. Each sector has a team dedicated to learning more about and serving the needs of its users.

Activities within each sector include attending and/or presenting at sectoral conferences, partnering on research activities, and representing NCDC at sectoral trade shows, just to name a few.

The following is a list of some recent user engagement activities that have occurred over the past year.

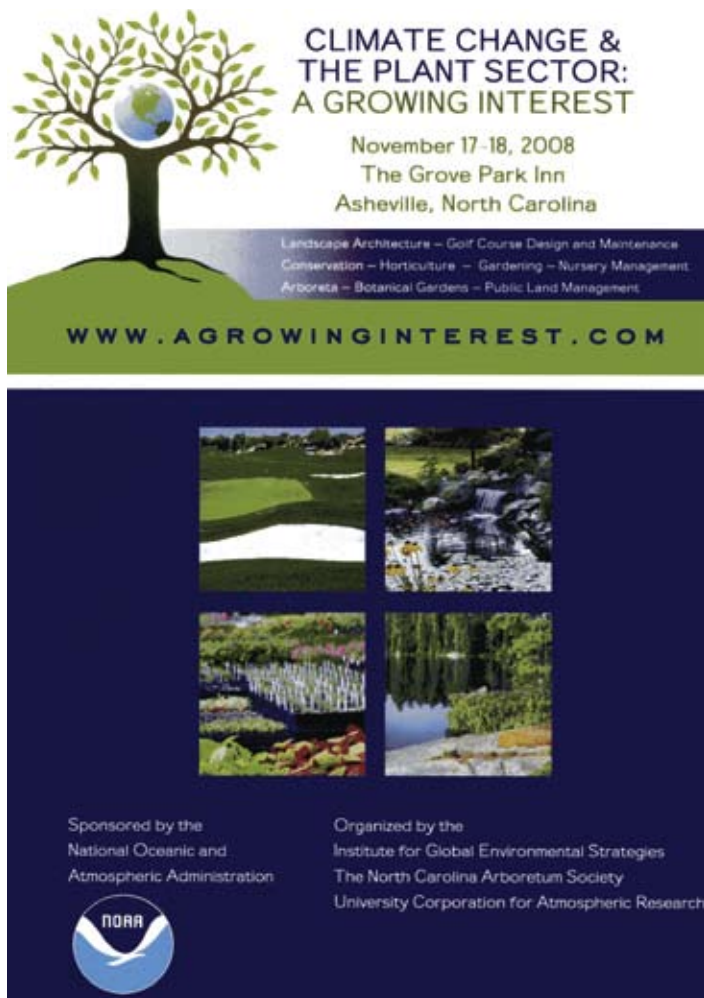
Water Resources

In April 2008, several NCDC scientists presented talks at the Biennial Southeast Regional Conference of the Association of State Dam Safety Officials in Asheville, NC. These presentations outlined NCDC's website and highlighted relevant data products that are useful for dam planning. A tour of NCDC was also included as part of the conference.

Agriculture

The USDA's Risk Management Agency (RMA) operates and manages the Federal Crop Insurance Corporation. Members of RMA visited NCDC to discuss how climate data can be used to investigate





fraudulent crop loss cases. Discussions continue as RMA explores the correlation between climate and crop yields.

NOAA's NCDC helped organize and sponsor a workshop entitled, *Climate Change and the Plant Sector: A Growing Interest* which was held on November 17 and 18. The workshop targeted landscape architects, golf course architects, nurseries, arboreta, and similar industries. This event provided an important first step in building a critical information bridge between the climate science community and the numerous, diverse business sectors and public interests that rely on the health and well-being of plants. There were more than 60 registered workshop attendees. The workshop website is <<http://www.agrowinginterest.com/index.htm>>.

Insurance

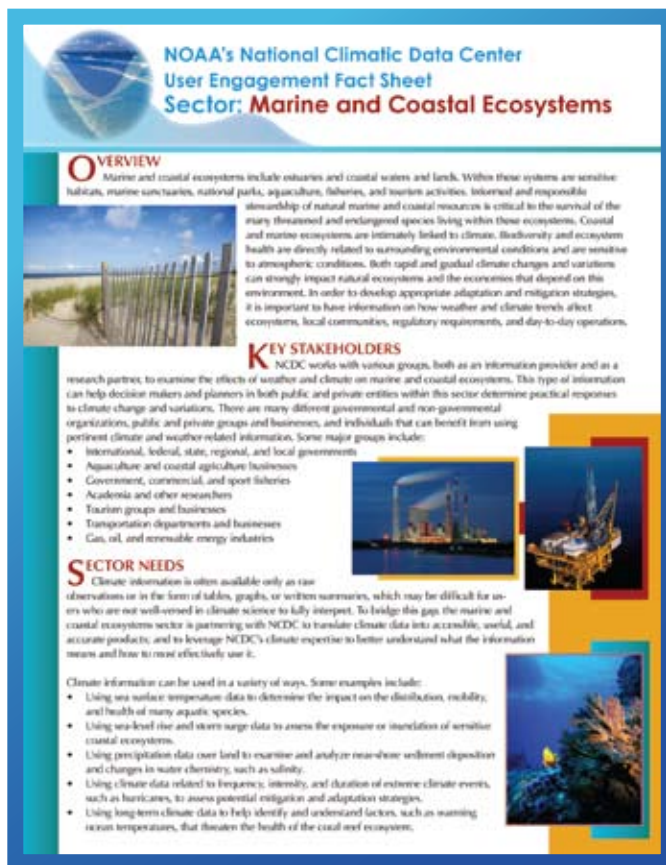
NCDC scientists engaged with leadership of the U.S. insurance/reinsurance industry throughout 2008. The activities for 2008 include: presenting the state of climate science at the 2008 Reinsurance Association of America (RAA) Catastrophe Modeling conference; discussing the data and modeling decision-making needs of insurance

analysts from Munich Re, AIR Worldwide, EQECAT, Strategic Risk Specialists, etc.; and acquiring an educational license for the Property Claims Services Catastrophe Cube insurance database to improve current NCDC data products.

We have also participated on several industry conference calls, one including the RAA Extreme Events committee. These meetings serve to establish high-level dialogue on the climate data needs of the insurance sector and what NOAA/NCDC is doing to meet those needs. Several ongoing NCDC climate data projects that are coming online to address insurance industry data needs include: IBTrACS, the Severe Weather Data Inventory, enhanced GIS data services, and development of the Climate Portal.

Marine and Coast Ecosystems

The potential impact of climate change on NOAA-managed coastal and marine resources has been identified as a significant issue that must be addressed. However, access and interpretability of adequate climate data and information remains an issue. With the complimentary goals of fostering increased interaction between NOAA units to better achieve NOAA's missions and providing more useful climate products and services to serve the needs of marine and coastal resource managers both within and external to NOAA, NCDC has been actively





engaged in developing working relationships with climate information users in the coastal and marine ecosystem community, including several NOAA offices.

Within this context, NCDC has developed a coastal and marine ecosystem climate data fact sheet, and reached out to NOAA's Coral Reef Watch/Coral Reef Conservation Program, National Marine Sanctuaries Program, National Centers for Coastal Ocean Science, Coral Reef Information System, and the NODC to develop strategies that will aid in developing and interpreting climate data and information products for the management and protection of coastal and marine ecosystems. Initial discussions were held at the Eleventh International Coral Reef Symposium in Fort Lauderdale, FL in June, 2008. These discussions were enhanced by several teleconferences and a round-table meeting in Silver Spring, MD in December, 2008.

Some of the common threads that were identified include the need for better sea surface temperature information near the world's coastlines, comprehensive atmosphere-ocean monitoring datasets and products, and greater analysis of climate information to discern climatic thresholds and triggers that may serve as early warnings for ecosystem impacts.

In 2009, NCDC is planning to conduct a climate data needs workshop at the Coastal and Estuarine Research Foundation conference, as well as working with the Coral Reef Conservation Program to enhance climate information dissemination in their regional reef manager workshops. Additional NOAA stakeholders (*e.g.*, The National Data Buoy Center) will be approached to collaborate with existing NOAA groups.

Tourism

Representatives from NOAA's NCDC attended the Climate, Weather and Tourism in North Carolina: Issues and Opportunities Workshop held at East Carolina University (ECU) in Greenville, NC, November 14 and 15. Tourism is a major economic driver for North Carolina with \$17.1 billion in travel expenditures, \$4.2 billion in payroll, and 198,900 residents employed. Despite the fundamental influence climate and weather have on tourism services across the state, there is limited understanding of the relationship between these phenomena and day-to-day business operations and long-term economic and environmental sustainability. The workshop was successful and promises to be a springboard for collaboration between tourism groups, government agencies, including NCDC, and academia, especially ECU. Approximately 100 people were in attendance. The workshop's website is <<http://www.ecu.edu/cs-acad/sustainabletourism/Climate-Tourism-Workshop-2008.cfm>>.

On April 16, 2008, NOAA's NCDC hosted a tour for participants of the Southeast Region Association of State Dam Safety Officials. The Association of State Dam Safety Officials is a national non-profit organization serving state dam safety programs and the broader dam safety community, which includes federal dam safety



professionals, dam owners and operators, engineering consultants, manufacturers, suppliers, academia, contractors, and others interested in improving dam safety.

FORMALIZING THE NOAA ECONOMICS INITIATIVE

In response to the growing importance of socioeconomic research with respect to industry decision making using environmental information, NCDC has led the development of a NOAA-wide economics website with its NOAA partners. Among the 2008 accomplishments are the following:

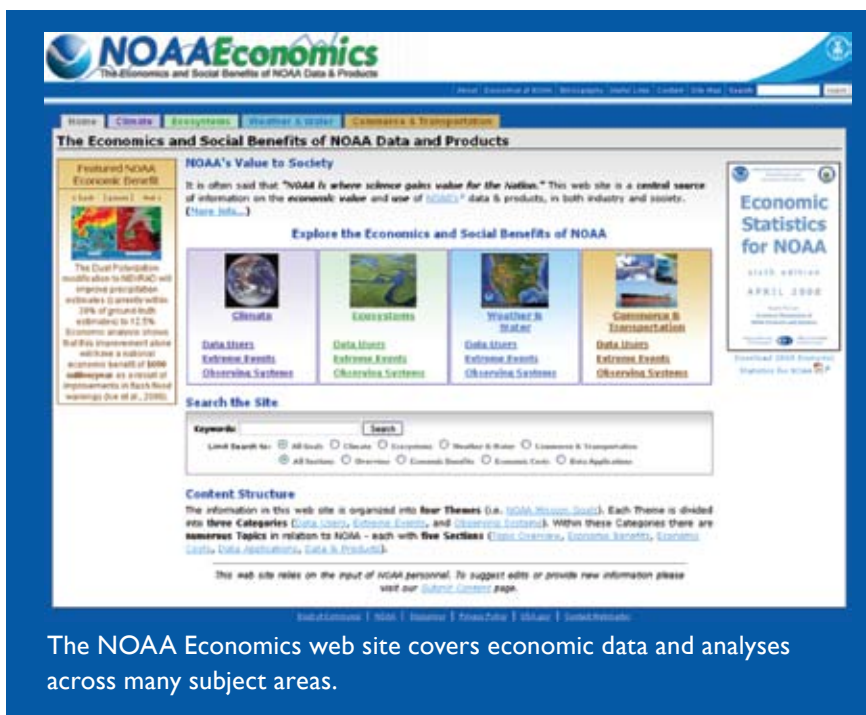
- In June, NCDC acquired <www.economics.noaa.gov> web domain and developed a team and terms of reference;
- Highlighted in a NOAA-wide e-mail by Vice Admiral Lautenbacher;
- Highlighted with a news article in the July edition of NOAA World;
- Website was linked under the About NOAA page, the Office of Program Planning and Integration page, the Community Collaborative rain, Hail and Snow Network page, and numerous others; and
- NC State Climate Office has a grant to survey the State Climate Offices and RCCs on the economic potential of state-level climate data products in support of NOAA Economics.

NOAA Economics presents a centralized source of information pertaining to the economic value and real-world application of NOAA's data products in decision making, as well as the economic costs of extreme events on the environment and society. The information is synthesized from a vast array of contemporary scientific literature and is presented in four themes (*i.e.*, Climate, Ecosystems, Weather and Water, and Commerce and Transportation). Each theme is then subdivided into three categories (Data Users, Extreme Events, and Observing Systems). Within these categories there are numerous topics in relation to NOAA—each with five summary Sections (Topic Overview, Economic Benefits, Economic Costs, Data Applications, and Data and Products). The

information is intended for a general audience and provides a clear, accurate, citable, but not overly academic explanation of NOAA's value to society. Common users of this web site include the general public, media, educators, congressional staffers and NOAA personnel. Peer-reviewed research that is primarily quantitative and other related content (see bulleted list below) may be submitted for possible inclusion on the site <www.economics.noaa.gov/?file=submit>.

As of January 2009, this website incorporates:

- 214 topic overview narratives, which provide societal and economic perspectives on the value of NOAA data and products (*i.e.*, for business, consumer, policy decision-making, *etc.*),
- 185 sources of peer-reviewed literature; 77 percent of this literature is hyper-linked to the source,
- 126 summaries on the economic benefits of/cost mitigation by NOAA data and products,
- 194 summaries regarding the economic costs/impacts of environmental extreme events,
- 720 data user-stories (*i.e.*, real-world accounts on the use of NOAA products in decision-making), and
- Hundreds of external hyperlinks to NOAA datasets/products and internal hyperlinks interconnecting many NOAA program missions and responsibilities.



The NOAA Economics web site covers economic data and analyses across many subject areas.

THE PACIFIC REGION INTEGRATED CLIMATOLOGY INFORMATION PRODUCTS

The Integrated Data and Environmental Applications (IDEA) Center's Pacific Region Integrated Climatology Information Products (PRICIP) project is a regional path finding activity towards the development of a national comprehensive extremes coastal climatology program. PRICIP is exploring how the climate-related processes that govern extreme storm events are expressed within and between three thematic areas: heavy rains, strong winds, and high seas. PRICIP is developing a suite of extremes climatology-related derived data and targeted information products that can be used by emergency managers, mitigation planners, government agencies, and decision-makers in key sectors including water and natural resource management, agriculture and fisheries, transportation and communication, and recreation and tourism.

Among the 2008 accomplishments are:

- Development and deployment of a PRICIP derived data products database via a Google Map-based query tool.



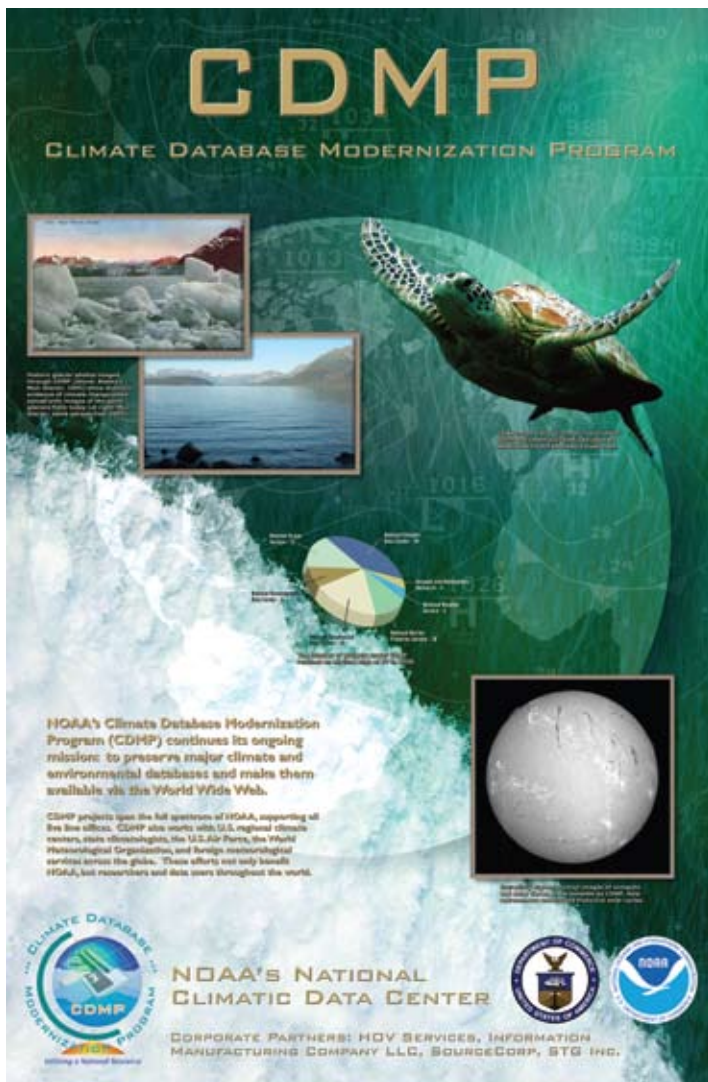
This prototype application represented the culmination of an initial round of data collection, analysis, and product development. The results of this effort were circulated to the Product Development team for review and comment. It can be found at <http://www.pricip.org/ddp.php>. Work has also commenced on the development of a formal PRICIP-NOAA website.

- Generation of historical event anatomy targeted information product portlet content for a total of eight different events. These event anatomies include a summary of sector-specific socioeconomic impacts associated with a particular extreme event, as well as its historic context climatologically. The intent is to convey the impacts associated with extreme events and the causes of them in a way that enables users to easily understand them. The event anatomies are also intended to familiarize users with *in-situ* and remotely sensed products typically employed to track and forecast weather and climate.
- Conduction of theme team and integration team meetings to update and refine the PRICIP theme area work plans and the work program in general. These meetings have served an important role in establishing a region and indicator-based approach to the development of a suite of extremes climatology-related information and products. They have also served to establish the need for PRICIP-wide data treatment standards and analysis protocols.

THE CLIMATE DATABASE MODERNIZATION PROGRAM

CDMP supports NOAA's mission to collect, integrate, assimilate, and effectively manage Earth observations on a global scale, ranging from atmospheric, weather, and climate observations to oceanic, coastal, and marine life observations. Many of these holdings, which are part of the U.S. National Archives, were originally recorded on paper, film, and other fragile media, and stored at various NOAA Centers. Prior to CDMP, not only were these valuable data sources mostly unavailable to the scientific community, but storage technology for the archives was not state-of-the-art. Without proper preservation of the media, the information they contained was in danger of being lost forever. Today, CDMP has greatly improved the preservation and access to NOAA's holdings by migrating many of these resources to new digital media.

Partnering with four private sector contractors, CDMP has placed online around 53 million weather and environmental images, available to researchers around the world via the Internet. The amount of data online has



grown from 1.75 terabytes in 2001 to over 10 terabytes in 2008. Major progress continues in making these data available through a number of NOAA web sites.

In addition, hourly weather records keyed through CDMP continue to be integrated into NCDC's digital database holdings, extending the period of record for many stations back into the 1890's. Additional daily data records keyed through the CDMP "Forts" projects is extending the data period back to the 18th century for several stations. CDMP has also enabled the keying of other important NOAA environmental data, ranging from below the oceans to the top of the ionosphere. The increase in the quality and quantity of historical data is helping researchers worldwide to improve real-time monitoring and forecasting of environmental, solar, and geophysical events.

NATION'S SCOREKEEPER

NOAA's National Climatic Data Center (NCDC) is the "Nation's Scorekeeper" in terms of addressing severe weather and climate events in their historical perspective.

NCDC tracks these events in the U.S. and globally that have great economic and societal impacts.

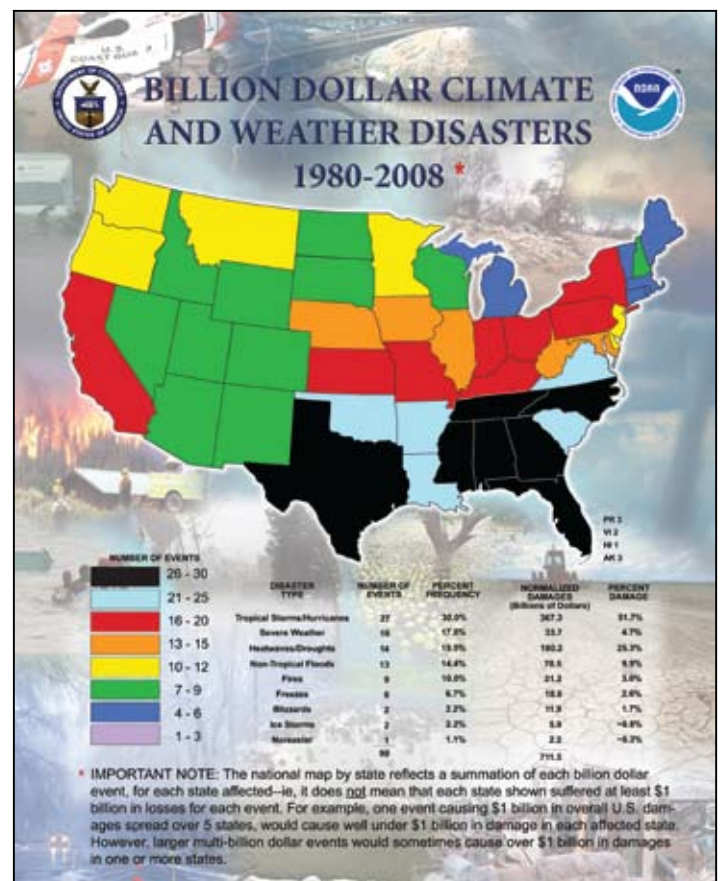
The U.S. has sustained 90 weather-related disasters over the past 29 years in which overall damages/costs reached or exceeded \$1 billion. The total normalized losses for the 90 events exceed \$700 billion. The national map color-coded by state reflects a summation of billion dollar events, for each state affected—i.e., it does not mean that each state shown suffered at least \$1 billion in losses for each event—large multi-billion dollar events sometimes cause over \$1 billion in damages in multiple states.

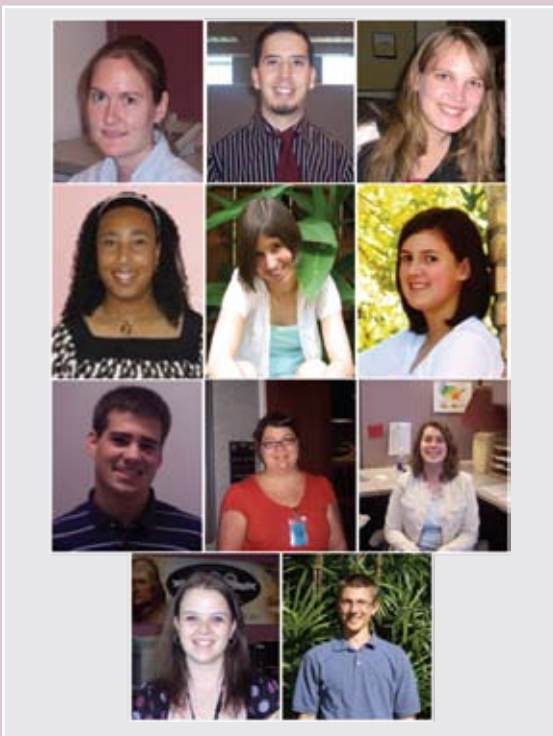
EDUCATION/OUTREACH/WORKSHOPS

EDUCATION ACTIVITIES AT NCDC IN 2008

Internships

NOAA's NCDC had 13 formal internships in 2008, four of which were sponsored by Ernest F. Hollings Undergraduate Scholarships. Ten of the internships were at NCDC-Asheville and the remaining three were conducted at the IDEA Center in Hawaii.





NCDC 2008 Interns: Top Row (left to right): K. Tippey, R. Mera, M. Purdy, 2nd Row from top (left to right): Z. Taylor, B. Norris, L. Bourgeois, 3rd Row from top (left to right): J. Grunin, J. Walker, A. Bowen, Bottom Row (left to right): S. Little, D. Young, Not pictured: N. Mullins and J. Wheeler

The interns worked on various projects ranging from USHCN-M, daily snowfall climatology, network security, RCCs collaborations and brochure, research for creation of the Masters degree in Climate Change in Society, the GOSIC, Pacific Region Integrated Climatology and Information Products (PRCIP), and Monitoring Climate Variability's Impact on Residential Energy Costs in the U.S., Handbook: Planning for Climate Change.

Public Speaking and Science Fair Judges

Employees of NCDC did a vast amount of outreach which involved serving as guest lecturers, instructors, or adjunct professors at several institutions of higher learning including, UNCA, the University of Hawaii, North Carolina Agricultural and Technical State University and Warren Wilson College. Additionally, a variety of

talks were given at area schools to students and educators spanning the breadth of kindergartners to colleges and universities.

Speakers' Bureaus

Both the IDEA Center in Hawaii and NCDC-Asheville have dedicated Speakers' Bureaus. And, there certainly was no shortage in the number of groups seeking speakers in 2008, especially as the southern U.S. drought continued and climate change became an almost daily item in the news. Groups ranged from scouts to the media to service organizations to local, state, and national officials to emergency responders. Also, for the second year in a row, Asheville employees served as speakers at the very successful local American Meteorological Society talks concerning climate change.

In addition, more than a dozen NCDC scientists were guest lecturers at the Climate and Society Masters-level course at UNCA.

In addition to the nearly 1,000 individuals who toured NCDC last year, a series of hands-on learning events also brought students to the Center. Three of these items are highlighted here.

Bring a Child to Work Day

NCDC's Bring a Child to Work Day was an enormous success with 52 students in attendance. This is by the far the largest number of students to date. The attendees enjoyed a variety of talks ranging from weather and climate to Doppler Radar to satellites to plant care. They



NCDC held Bring a Child to Work Day on April 29th with 52 students in attendance.



One of the three CLIMBE camps which visited NCDC this summer

Global Online First Responder Student Training (October 24)

took a tour of the building and visited the ERC Broadband, Museum, Magic Planet and TouchTable displays. The balloon launch, held in previous years, was replaced with a segment about plants. Each child took home a bag of bean seeds to learn about germination and Dixie cups filled with potting soil and flower seeds. NCDC employee, Tom Ross, even donated a maple sapling to each participant.

Center for Learning and Investigation in Mountain Backcountry Ecosystems Camps (June 15, July 1 and 15)

The Center for Learning and Investigation in Mountain Backcountry Ecosystems (CLIMBE) is funded by a grant from Burroughs-Wellcome. The camp is an environmental training and research center operating out of the Montreat College Campus which provides young scientists with hands-on field data collection and analysis. The program is free for gifted rising ninth through twelfth grade students who have an interest in science and outdoor pursuits.

Program Goals:

- To improve student competence in science
- To nurture student enthusiasm for science
- To increase student interest in pursuing careers in science

While at NCDC, participants in the CLIMBE camps participated in talks dealing with: Weather/ Climatology, Radar, Satellite, the TouchTable, as well as Dendrochronology.

The Global Online First Responder Student Training (GO-FIRST) is designed, developed, and directed by a global team of public safety and education leaders dedicated to preparing young people for the Mission of Life by connecting, inspiring and energizing them with the values, skills, sciences, technologies and sports, of First Responders around the world.

The GO-FIRST participants received several presentations about climate and weather at NCDC. They took part in a mock-hurricane preparedness drill based on actual situations encountered in September's Hurricane Ike by government employees and first responders. The students also honed their "on-camera" skills by developing a skit and presenting it via NCDC's audio visual equipment. It was truly a day of fun and learning for all!



Tamara Houston points out items of interest to GO-FIRST participants

NCDC WORKSHOPS

National Polar-Orbiting Operational Environmental Satellite System Land Product Validation Planning Preparatory Project Workshop

(February 2008)

NCDC hosted a two-day workshop attended by 40 invited members of academia, the National Aeronautics and Space Administration (NASA), NOAA, Prime Contractor, and the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO). This was one of a series of discipline-focused product validation planning workshops initiated by the IPO, and an NCDC scientist was tapped by the IPO to serve as the Land Validation Lead. The workshop identified acceptable approaches and requirements for streamlined NPOESS Land Environmental Data Record validation given Earth Observation System lessons learned; as well as the critical validation resources available or in development; and potential gaps in current capabilities. The workshop led to the development of the 68 page NPOESS Preparatory Project (NPP) Land Validation Plan

International Workshop on the Retrieval and Use of Land Surface Temperature: Bridging the Gaps

(April 2008)

NCDC hosted an international workshop sponsored by the Global Energy and Water Cycle Experiment Radiation Panel in partnership with NCDC and NASA. The two and one-half day workshop was attended by over 50 participants, representing 29 institutions and 8 countries. The group included land surface temperature (LST) data producers, modelers, and members from the LST user/applications community. The workshop goals were to identify the state of the science of LST estimates from remote sensing platforms, models, and *in situ* approaches, specify the requirements for LST products from the different user communities (climate research, weather forecast, drought monitoring, other), identify the gaps between state of the science and the user community requirements, and discuss solutions to bridge these gaps. NCDC is helping to implement workshop recommendations in 2009.

National Polar-Orbiting Operational Environmental Satellite System Science Advisory Board Meeting

(September 2008)

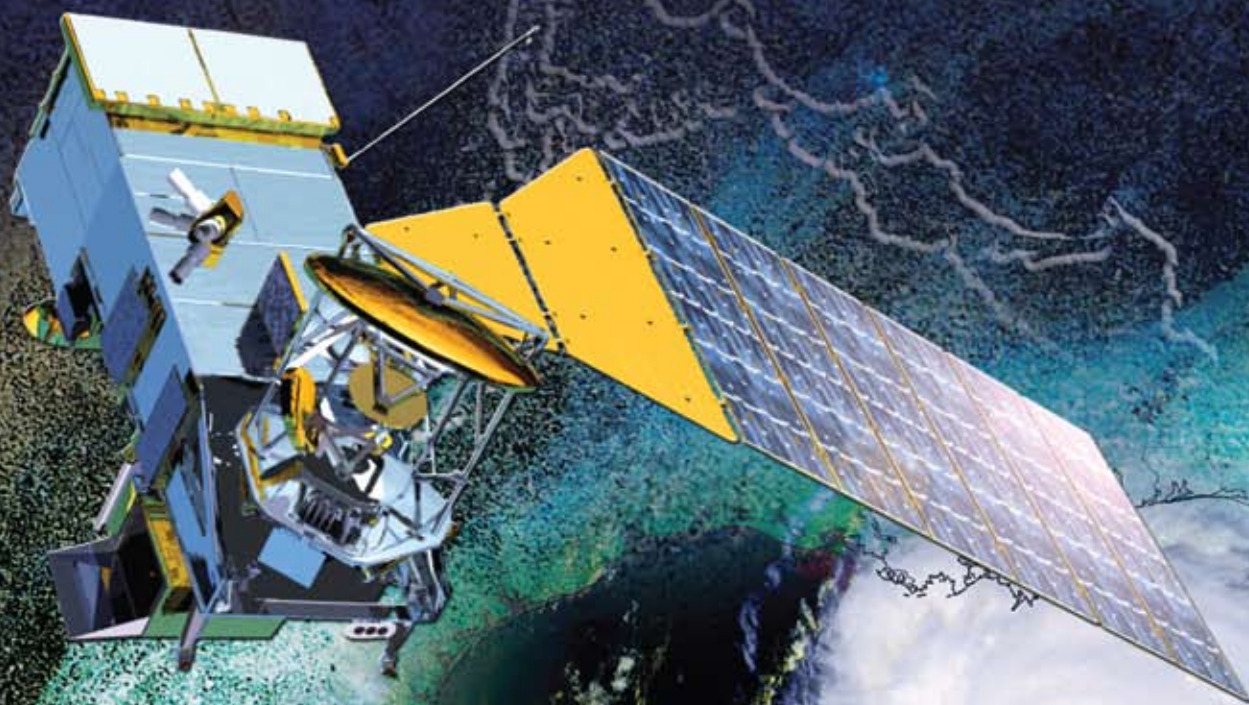
NCDC hosted approximately 25 senior scientists, representing academia, industry, government, and non-profit organizations, for the September meeting of the NPOESS Science Advisory Board (SAT). NCDC is one of two National Data Centers that will archive NPP and NPOESS data, and it is leading NOAA's Scientific Data Stewardship Project that will produce CDRs and CIRs based in part on NPP/NPOESS data. The SAT is a team of preeminent consultant/subcontractor scientists that provides independent top-level guidance to the NPOESS Program leadership concerning science and operations aspects of NPP and NPOESS—within bounds of government direction and resources. The is demonstrating leadership through their activities relating to climate data products, the CLASS data handling system, and NPP/NPOESS calibration and validation data.

Welcome

NPOESS SCIENCE ADVISORY TEAM

September 3-4, 2008

Room 400



Hosted by
NOAA's National Climatic Data Center

NOAA NCDC PERSONNEL



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NOTE: NOAA NCDC PERSONNEL INDICATED WITH AN “*” EITHER RETIRED, RESIGNED, OR TRANSFERRED DURING THE 2008 CALENDAR YEAR.

ACRONYMS AND ABBREVIATIONS

AASC American Association of State Climatologists	GRUAN GCOS Reference Upper Air Network	NWS National Weather Service
ACIS Applied Climate Information System	HIS Hydrologic Information System	OAR Office of Oceanic and Atmospheric Research
AgACIS Agriculture Applied Climate Information System	IBTrACS International Best Track Archive for Climate Stewardship	PRICIP Pacific Region Integrated Climatology Information Products
ARH Alaska Region Headquarters	IT Information Technology	RAA Reinsurance Association of America
ARSCO AASC-Recognized State Climate Office	IDEA Integrated Data and Environmental Applications (Center)	RCC Regional Climate Center
ATDD Atmospheric Turbulence and Diffusion Division	IPO Integrated Program Office	RCN Reference Climate Network
CCSP Climate Change Science Program	LST land surface temperature	RENCI Renaissance Computing Institute
CDMP Climate Database Modernization Program	MOU Memorandum of Understanding	RMA Risk Management Agency
CDR Climate Data Record	MSC Meteorological Service of Canada	SAN storage area network
CIO Chief Information Officer	NASA National Aeronautics and Space Administration	SAT Science Advisory Board
CIR Climate Information Record	NCAR National Center for Atmospheric Research	SCEP State Climate Exchange Program
CLASS Comprehensive Large Array-Data Stewardship System	NCDC National Climatic Data Center	STRI Smithsonian Tropical Research Institute
CLIMBE Center for Learning and Investigation in Mountain Backcountry Ecosystems	NCS NOAA Climate Services	THORPEX The Observing System Research and Predictability Experiment
COOP National Cooperative Observer Network	NESDIS National Environmental Satellite, Data, and Information Service	TIGGE THORPEX Interactive Grand Global Ensemble
CPC Climate Prediction Center	NGDC National Geophysical Data Center	UNCA University of North Carolina Asheville
CUAHSI Consortium of Universities for the Advancement of Hydrologic Science	NIDIS National Integrated Drought Information System	UNFCCC United Nations Framework Convention for Climate Change
DAARWG Data Archive and Access Requirements Working Group	NOAA National Oceanic and Atmospheric Administration	USCRN U.S. Climate Reference Network
ECU East Carolina University	NODC National Oceanic Data Center	USDA U.S. Department of Agriculture
ESC Executive Steering Committee	NOMADS National Operational Model Archive and Distribution System	USDP U.S. Drought Portal
FY Fiscal Year	NOS National Ocean Service	USGS U.S. Geological Survey
GCOS Global Climate Observing System	NPOESS National Polar-Orbiting Operational Environmental Satellite System	USHCN-M U.S. Historical Climatology Network Modernization
GEOSS Global Earth Observation System of Systems	NPP NPOESS Preparatory Project	WDC World Data Center
GIS Geographical Information System	NPS National Park Service	WMO World Meteorological Organization
GO-FIRST Global Online First Responder Student Training	NRC National Research Council	
GOOS Global Ocean Observing System	NSOF NOAA's Satellite Operations Facility	
GOSIC Global Observing Systems Information Center	NVDS NOAA Virtual Data System	

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